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COOPERATIVE AGREEMENT NUMBER DAMD17-95-2-5011

TITLE: Drug Development and Conservation of Biodiversity in West and Central Africa

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CONTRACTING ORGANIZATION: Bioresources Development and Conservation Programme
Silver Spring, Maryland 20904

REPORT DATE: August 1998

TYPE OF REPORT: Annual

PREPARED FOR: Commander
U.S. Army Medical Research and Materiel Command
Fort Detrick, Frederick, Maryland 21702-5012

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 1998	Annual (17 Jul 97 - 16 Jul 98)

4. TITLE AND SUBTITLE
Drug Development and Conservation of Biodiversity in West and Central Africa

5. FUNDING NUMBERS
DAMD17-95-2-5011

6. AUTHOR(S)
Maurice M. Iwu

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Bioresources Development and Conservation Programme
Silver Spring, Maryland 20904

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Commander
U.S. Army Medical Research and Materiel Command
Fort Detrick, Frederick, Maryland 21702-5012

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200*

The Bioresources Development and Conservation Programme (BDCP) made progress in all aspects of its scope of work during the period under review. Our laboratories at International Center for Ethnomedicine and Drug Development, Nigeria and University of Dschang, Cameroon processed and extracted 132 selected plants. These extracts were screened in anti-microbial assays, Minimum inhibitory Concentration (MIC) and Brine Shrimp Lethality assay. Further bioassay guided fractionation and structural elucidation of phytoconstituents is being carried out on the extracts, which showed noteworthy activity. We have bulk extracted 12 plants for pre-clinical pharmacological and biochemical studies. Five workshops were held on Bioprospecting; Standardization and development of herbal medicine and Economic value assessment. Some of the workshops were held in conjunction with United Nations, Organization of African Unity and host country governments. The Board for the Trust Fund for Integrated Rural Development and Traditional Medicine (FIRD-TM) was formally inaugurated. The fund has attracted funds from government and private industries. Biodiversity Development Institute of Nigeria (BioDin) was established during this project period. The aim of this institute is to promote sustainable utilization and conservation of biological resources through research, inventory, training and information management. Socio-economic valuation projects were completed in some of our project sites in Nigeria and Cameroon. Data has been obtained from household studies and market surveys in these areas and used in updating the Computerized Information System on African Medicinal and Aromatic Plants (CISAMAP).

14. SUBJECT TERMS
Plant collection, extraction, economic value assessment, training conservation, ethnobotany.

15. NUMBER OF PAGES
58

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

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Bioresources Development and Conservation Programme (BDCP)

DRUG DEVELOPMENT AND CONSERVATION OF BIODIVERSITY IN WEST AND CENTRAL AFRICA

ANNUAL REPORT: AP 2 and 5
July 17, 1997- July 16, 1998

4. TABLE OF CONTENT

INTRODUCTION:

West-Central Africa contains the largest moist equitorial forest on the continent. This forest is vital for the well-being of the communities who live around it. The species richness of this region and its importance as a center for plant endemism makes it a key global center for bodiversity conservation. It is a unique area with great potential as a source of new molecular leads for drug development.

The International Cooperative Biodiversity Group (ICBG) on Drug Development and Conservation of Biodiversity in West and Central Africa demonstrates that sustainable drug development is a viable alternative to such destructive activities as a source of income for local communities. The overiding concept is to increase the net worth of tropical forests as living resource base and to demonstrate the feasibility of an ecological management strategy which uses drug development as a catalyst for the conservation of biological diversity.

The ICBG goals are being achieved through a combination of the following approaches:

1. assisting with the development of drugs while addressing the priority health needs of the United States and the participating countries;
2. developing inventories of native species and indigenous knowledge;

3. training targeted towards achieving the research goals of the program and meeting the needs of the participating countries and; 4. improving the scientific infrastructure within the host country.

The main target therapeutic categories are tropical diseases such as malaria, leishmaniasis and trypanosomiasis. In the drug development component of the program, the emphasis is on identification of new therapeutic leads over as wide variety of plant sources as can be possible with the available resources. The ICBG research plan emphasizes the development of drugs for tropical diseases as well as high quality, affordable herbal medicines. We are also investigating new anti-HIV, anti-cancer, CNS drugs and other opportunistic infections. Thus, there is a great need for a highly selective plant selection strategy.

Bioresources Development and Conservation Progamme uses a carefully designed approach which combines selection based on ethnomedical uses, chemical and biological profile of plant candidates and information from literature and chemotaxonomical evaluation.

The project sites are: University of Dschang, Cameroon; Korup Forests, Cameroon; International Centre for Ethnomedicine and Drug Development, Nsukka, Nigeria, Okwangwo, Ehima and Owai Forests, Nigeria; University of Pittsburgh, U.S.A.

Compensation and Benefit Sharing Plan:

In accordance with this ICBG's *General Principles of Benefit Sharing*, we have adopted a framework for reciprocity and equitable distribution of benefits from biodiversity which addresses our concern for participatory development, environmental sustainability and poverty alleviation. This also deals directly with issues regarding research scope and administration, intellectual property rights (including licensing, royalty sharing, trademark, copyright, and trade secrets), and sourcing. BDCP compensation plan in this program was based on deriving maximum benefits from the process of drug discovery rather than the promise of huge royalties

that may never materialize. In doing this, we have equitably distributed benefits to individual healers involved, Associations of Traditional Healers as well as various local communities in both Nigeria and Cameroon. We have three forms of compensation viz:

a. Short Term and Immediate Compensation

Collection fees to individuals and communities: The model used presently by the Bioresources Development and Conservation Programme (BDCP) in its bioresources prospecting projects has been adopted. Plants will be collected directly from local communities and payment and compensation will be effected in three modes. First a "small" cash payment will be made to the informant/collector. Secondly, the community will be assisted in their development projects, and thirdly the medical member(s) of the ethnobotanical team will consult with the local healers and lend help to them in treating some acute life threatening conditions.

b. Long-term benefits

This refers to those aspects of the CRDA with direct relevance to the distribution of royalties, trade secrets with regards to traditional knowledge, and sourcing issues.The royalty derived from licensing of the drugs developed will be distributed through a legal Trust Fund which has been established.

c. Trust Fund:

The royalty generated from the licensing of the drugs developed during this project will be distributed through a legal Trust Fund which has been established for this purpose. Each community is asked to establish a consultative committee drawn from the executive of the village unions or town associations, village heads and professional guild of healers. It is the village committee that make decisions and select priorities regarding compensations and projects and BDCP has used this approach successfully. The Fund for Integrated Rural Development and Traditional Medicine (FIRD-TM) is completely independent but will administer the funds only for the purposes outlined in its Charter. FIRD-TM has an independent board composed of leaders of traditional healers' association, senior government officials, representatives of village councils and technical experts from scientific institutions. It is our position that when determining compensation for access to genetic resources that emphasis should be placed on capacity building rather than short term cash payments. Source countries should endeavor to add value to their resources before trading the samples. The objective is to build a lasting relationship between the parties rather than negotiating for immediate compensation. If properly planned, biological resources could be a viable vehicle for sustainable development.

d. Training and Capacity Building

The project provides for various training programs both in-country and in the United States for ecologists, biologists, chemists, pharmacologists, ethnobiologists and field taxonomists. This non-monetary benefit will strengthen the ability of the scientists of the two countries to conduct similar projects in the future.

Scope and Objectives:

The general objectives of this ICBG include the following:

A) To provide an ethnbobotanical inventory of the plants in the selected study area. Samples will be collected from the biodiversity plots and from wild flora for screening for possible

biological activity. The database on African medicinal plants Afrimed, will be expanded to include plants collected during the proposed project.

B) To establish permanent biodiversity plots for monitoring and documenting changes in plant diversity and ecology of the area. The plots will provide long-term data on the growth, mortality, regeneration, and dynamics of forest trees.

C) To conduct an economic value assessment of the biological resources in the study area. This component of the study has four objectives:

- to quantify the economic value of bioresources for comparison with other land use options;
- to prioritize the productioon and marketing of bioresources in local markets which could provide a source of income for local residents;
- to provide baseline data for the formulation of a sustainable management plan for the forest resources;
- to train local natural resource managers and users at both national and community between conservation and development.

D) To assist in capacity building in the source countries, through training of African scientists in the areas of ethnobiology, inventory, phytochemical analysis and research management.

E) The ICBG aims at strenghtening the capacity of Bioresources development and Conservation Programme (BDCP) and other local institutions to enable them to be more effective in resource management and conservation programs and to continue the activities initiated even after the end of this project. Training will be organized in parataxonomy and economic value assessment for local communities.

F) The ICBG will identify medicinal plants from West and Central African rainforest that contains new biologically active compounds. An inventory of plant extracts will be maintained so that retesting in future as more sensitive test systems becomes available will not necessitate re-collection and processing. To develop up to pre-clinical stage active isolates for the treatment of tropical diseases. Other major therapeutic classes to be investigated include antiviral (such as anti-HIV), anticancer, antifungal, and CNS activity. Compounds will also be assayed for cardiovascular, antiinflammatory and immune-modulatory activities.

Scope of Work Under CRDA No: DAMD 17-95-2-5011

1. Select and collect plant materials for the biological activity screening as described in the ICBG project document.
2. Prepare extracts of plant materials and maintain an inventory of such extracts
3. Perform preliminary bioassays on selected plant materials
4. Initiate and conduct an ethnobotanical survey of plants used in traditional medicine for specific diseases
5. Conduct economic value assessment of the biological resources in the study area.
6. Provide training in parataxonomy and economic value assessment of biological resources for students and scientists in the project area.
7. Coordinate and facilitate other activities of the ICBG in Cameroon and Nigeria as stipulated under the CRADA establishing this ICBG.

ACTIVITIES:

The proposed activities of BDCP under Associate Programs 2 and 5 are:

1. Plant Collection
2. Phytochemistry
   - Plant Extraction for bioassays
   Extract Fractionation/ Isolation/ Structure Elucidation.
3. Brine shrimp and antimicrobial screening
4. Ethnobiological survey and Economic value assessment
5. Conservation
   -Inventory of species
   -Support for Extractive Reserves
6. Database
   -Plant uses and distribution
   -Extracts and Isolates, distribution, location and quantity
   -Developmental Drug status
7. Training Programs
   -Ethnobotany
   -Ecological evaluation techniques
   -Field taxonomy
   -Phytochemistry
8. Infrastuctural and Capacity building
   - Trust Funds
   -Equipment
   -Communities Forest Areas

6. SCIENTIFIC RESULTS:

6-A. ETHNOBIOLOGICAL SURVEY:

We have conducted twelve ethnobotanical field trips in Nigeria and Cameroon altogether. ICBG has collected over 500 plants for the treatment of various diseases and the herbarium specimen have been prepared for these plants. We also maintain an inventory of plants used in the region for healing. An ethnobotanical inventory of the plants in the selected study area is maintained. Samples are collected from the biodiversity plots and from wild flora for screening for possible biological activity. The database on African medicinal plants AFRIMED, has been expanded to include plants collected during this project period.

In-depth ethnobotanical survey was conducted in four identified zones within the project area in Nigeria: Enugu-Nsukka-Abakaliki, Benue-Jos-Taraba, Owerri-Port Harcourt, and Calabar-Ogoja zones. In Cameroon, survey was done in the North West and the South West zones.

Our primary source of plants for drug development has been from a selected list of prioritized from the analysis of the ethnobotanical information, chemotaxonomy and correlation with previous information from AFRIMED Database and/or commercially available databases. The

biodiversity plots established by AP-1 also provide us with permanent "Nature Laboratories", in which random sampling will be made of only species that are considered unique from a taxonomic viewpoint or previously unknown. An oral contraceptive plant discovered through our ethnobiological survey in the Benue-Jos-Taraba zone in Nigeria is currently being investigated. We are collaborating with University of Jos, Nigeria in the clinical evaluation of this plant.

6-B. Plant Collection:

More plant collection was done this year using four basic methods in the selection of plants investigated for biological activity, viz:
- selection based on ethnomedical uses
- leads from literature searches and review of databases
- chemotaxonomic approaches
- random selection of plants followed by mass screening.

This ICBG team has developed a customized approach which involves a carefully designed ethnomedical survey, followed by chemical and biological profile of plant candidates, and finally integrating the result with information from literature and chemotaxonomical evaluation to generate a highly selective prioritized list. This method has been tested in the search for new antimalarial, antileishmanials and antiviral drugs. In each case the correlating factor was more than 85%.

6-C. Plant Selection Strategies:

The primary sources of plants for drug development is from a selected list, prioritized from analysis of the ethnobotanical information, chemotaxonomy and a correlation with previous information from AFRIMED database and/ or commercially available databases.

6-D. Plant De-replication Protocol:

Plants collected from the ethnobotanical field trips were dereplicated according to a customized protocol. This ICBG utilized a multidisciplinary team of experts in botany, chemistry, biology, clinical pharmacology and medical practitioners in a collaborative effort to identify and collect plant species with the greatest potential for biological activity. The collected plants were properly catalogued, voucher specimens obtained, then processed, extracted and tested for biological activity.

6-E. PHYTOCHEMISTRY:

EXTRACTION:

The following plant extracts were performed at InterCEDD:

1. Oil extracts from *Hyptis Suaveolens* leaves. Weight of extract = 5.3ml.

2. CH_2Cl_2 and CH_3OH extracts of *Uvaria chamae* roots.
   Weight of dry extracts = 10.1g and 18.8g respectively.

3. CH_2Cl_2 and CH_3OH extract of *Enantia chloranta* roots.
   Weight of dry extract = 21.2 and 7.8g respectively.

4. Ch_3OH extract of *Ritchiea Capparaides* roots. Weight of dry extract = 11.4g

5. CH_2Cl_2 and CH_3OH of *Moringa olifera* leaves/stems.
Weight of dry extracts = 12.7g and 10.8g respectively.

6. CH_2Cl_2 and CH_3OH extracts of *Boerharia diffusa* roots.
Weight of dry extracts = 3.8g and 6.2g respectively

7. CH_2Cl_2 and CH_3OH extracts of *Guarea thompsonii* stem bark.
Weight of dry extracts = 8.7g and 49g respectively.

8. CH2Cl2 and CH3OH extracts of *Detarium microcarpum* stem bark.
Weight of dry extracts = 1.3g and 102.4g respectively.

9. CH_2Cl_2 and CH_3OH extracts of *Flacourtia flavescence* roots.
Weight of dry extracts = 16.8g and 37.6g respectively.

10. CH_2Cl_2 and CH_3OH extracts of *Lophira lanceolata* roots.
Weight of dry extracts = 5.2 and 6.3g respectively.

11. CH_2Cl_2 and CH_3OH extracts of *Moringa olifera* stem bark.
Weight of dry extracts = 1.5 and 2.3g respectively.

12. CH_2Cl_2 and CH_3OH extracts of fresh *Gongronema latifolia* leaves/stems from Nsukka (Dry Season Sample). Weight of dry extracts = 6.9g and 17.5g respectively.

13. CH_2Cl_2 and CH_3OH extracts of dry *Gongronema latifolia* leaves/stems from Nsukka .(Dry Season Sample). Weight of dry extracts = 7.8g and 20.3g respectively.

14. CH_2Cl_2 and CH_3OH extracts of fresh *Gongronema latifolia* leaves/stems from Awka (Dry Season Sample). Weight of dry extracts = 4.5g and 6.1g respectively.

15. CH_2Cl_2 and CH_3OH extracts of dry *Gongronema latifolia* leaves/stems from Awka (Dry Season Sample). Weight of dry extracts = 7.7g and 21.1g respectively.

16. CH_2Cl_2 and CH_3OH extracts of fresh *Gongronema latifolia* leaves/stems from Mbano (Dry Season Sample). Weight of dry extracts = 8.9g and 33.1g respectively.

17. CH_2Cl_2 and CH_3OH extracts of fresh *Gongronema latifolia* leaves/stems from Mbano(Dry Season Sample). Weight of dry extracts = 8.1g and 3.1g respectively.

18. CH_2Cl_2 and CH_3OH extracts of fresh *Gongronema latifolia* leaves/stems from Cross River State (Dry Season Sample). Weight of dry extracts = 4.8g and 26.2g respectively.

19. CH_2Cl_2 and CH_3OH extracts of fresh *Gongronema latifolia* leaves/stems from Cross River State (Dry Season Sample). Weight of dry extracts = 11.2g and 27.2g respectively.

20. CH_2Cl_2 and CH_3OH extracts of *Chasmenthera* roots.
Weight of dry extracts = 6.8g and 6.9g respectively.

21. CH_2Cl_2 and CH_3OH extracts of *Spondias mombin* stem bark.
Weight of dry extracts = 1.3g and 16.1g respectively.

22. CH_2Cl_2 and CH_3OH extracts of *Garcinia kola* stem bark.
Weight of dry extracts = 20.1g and 78.3g respectively.

23. CH_2Cl_2 and CH_3OH extracts of *Newbouldia laevis* stem bark.
Weight of dry extracts = 1.4g and 26.2g respectively.

24. CH_2Cl_2 and CH_3OH extracts of fresh *Ficus thonningii* leaves/stems.
Weight of dry extracts = 1.1g and 4.7g respectively.

25. CH_2Cl_2 and CH_3OH extracts of dry *Ficus thonningii* leaves/stems.
Weight of dry extracts = 13.5g and 14.2g respectively.

26. CH_2Cl_2 and CH_3OH extracts of *Cassia siamea* leaves/stems.
Weight of dry extracts = 7.2g and 13.8g respectively.

27. CH_3OH extract of fresh *Cassia siamea* leaves/stems.
Weight of dry extract = 12.3g

28. CH_2Cl_2 and CH_3OH extracts of *Hymenocardia acida* roots.
Weight of dry extracts = 2g and 7.5g respectively.

29. CH_2Cl_2 and CH_3OH extracts of *Bryphyllum pinnata* leaves.
Weight of dry extracts = 2.5g and 2.6g respectively.

30. CH_2Cl_2 and CH_3OH extracts of *Garcinia kola* seed coat.
Weight of dry extracts = 23.2g and 21.1g respectively.

31. CH_2Cl_2 and CH_3OH extracts of *Milicia excelsa* stem bark.
Weight of dry extract = 16.8g and 17.8g respectively.

32. CH_2Cl_2 and CH_3OH extracts of *Enantia chloronta* stem bark.
Weight of dry extracts = 20.5g and 20.3g respectively.

33. CH_2Cl_2 and CH_3OH extracts of *Pycnanthus angolensis* stem bark.
Weight of dry extracts = 2.1g and 20.2g respectively.

34. CH_2Cl_2 and CH_3OH extracts of *Adnopus senegalensis* fruits.
Weight of dry extracts = 3.5g and 11.2g respectively.

35. H_2o extract of dry *Gongronema latifolia* leaves/stems from Cross River State.
Weight of dry extract = 1.2g.

SOLVENT RECOVERY: Over 40 litres of pure methylene chloride was recovered.

TLC ANALYSIS: Trial TLC analysis was carried out using various combinations of Solvents to determine the best Solvents that would separate the Methylene Chloride Methanol and Methylene Chloride/Methanol extracts into various components.

After several trials, it was discovered that the best solvent system will separate components of methylene chloride extract is Methylene chloride and methanol (95:1).

For Methanol extracts, the best resolution was achieved with Chloroform; Petroleum ether; diethyl ether (10:7:3).

These solvent systems were used to analyze all the *Gongronema latifolia* leaves/stems collected from Nsukka, Awka, Mbano and Awi during rainy and dry seasons.

According to the result, there was no seasonal variation. Nine (9) distinct bands were observed in all of them under day-light and seven (7) good bands under UV light.

The nine (9) bands under day-light were confirmed by iodine vapour analysis while ammonia vapour did not show any significant difference in terms of visibility of sports.

Bioassay-guided Purification of Active Extracts and Structure Elucidation of Phytoconstituents.

In this report period, some extracts which showed noteworthy activity in the antimalarial screen were selected for bioassay-guided fractionation to isolate the active constituents. These include extracts from :

a) *Pentadiplandra brazzeana* Bail. (Pentadiplandraceae).
P brazzeana is a climber with thick tuberous roots and very sweet berries found in the savannah region of Africa. It is a highly priced spice and also used in ethnomedical preparations.
EtOH extracts of roots : IC_{50} : D-6 4190 ng/ml
W-2 6898 ng/ml
Partial fractionation of these extracts have yielded so far four urea derivatives **1,2,3** and **4.** Compound **2** shows marginal activity (IC_{50} D-6, 21184 ng/ml and W-2, 23365ng/ml) while the other three are inactive. The polar fractions have not yet been purified. (compounds screened, NPB_1, NPB_2, NPB_3 and NPB_4)

b) *Lepidobotrys staudii* (Lepidobotryaceae)
IC_{50} : CH_2Cl_2 7046.4 (D-6), 7733.3 (W-2)
Acetone 2701.7 (D-6), 2365.9 (W-2)

A sequential solvent/solvent partioning protocol provided hexane-, CH_2Cl_2-, EtOAc- and MeOH-soluble fractions. The combined MeOH and EtOAc-soluble fractions was further fractionated to give

acetone and MeOH-soluble fractions. All these fractions were sent in for antimalarial screening. While the results of the screening were being awaited, the hexane extract was subjected to successive column chromatography on Si gel to give six pure triterpenoids (NLS_1, NLS_4, NLS_7, NLS_{10}, NLS_{11} and NLS_{12}). A combination of gel filtration using sephadex LH-20, column chromatography and MPLC purification of the very polar acetone extracts yielded only partially resolved mixtures. LSX1, LSX2, LSX3 LSX4 and LSX5. The above pure compounds and fractions gave the following results in the antimalarial screen.

Table A-1 : Antimalarial Activity of *L. staudtii* compounds and Extracts

Name of cpd or Extract	IC_{50} in ng/ml	
	Clone D-6	**Clone-W-2**
Acetone	8099	4527
MeOH	8435	6327
LSX1	3390	2178
LSX2	7013	4882
LSX3	7323	5153
LSX4	10617	6822
LSX5	9221	6823
NLS7	22529	22279
NLS12	18000	12207

The pure compounds whose structures have now been determined, NLS_1, NLS_{10}, NLS_{11} and NLS_{12} were devoid of activity. Further purification of LSX_1, LSX_2 and LSX_3 is in progress.

3. *Xymolos monospora* (Har.) Baill. ex Warb (Miniaceae)

CH_2Cl_2,.....IC_{50} : D-6= 1847ng/ml
W-2=3400ng/ml.
MeOH,..... IC_{50}: D-6=3099ng/ml
W-2=5841ng/ml

Since plants of the family Moniaceae contain alkaloids, the CH_2Cl_2 extract was treated with 10% aqueous sulfamic acid. The acidic fraction containing alkaloid hydrochlorides was basified with NH_3, extracted with CH_2Cl_2, and the organic extract concentrated under vacuum to give the total alkaloids. Repeated chromatography of the extract yielded 4 compounds. These alkaloids are awaiting submision for testing.

4) *Renealmia cincinnata* (K. Schum) Bak (Zingiberaceae)

R. cincinnata is a spice in Cameroon. Its leaves and seeds are also used in traditional medicine. There are major constituent of the steam-bath used against high fevers. The CH_2Cl_2 extract (awaiting anti-malarial screening) has afforded four sesquiterpenoids and a flavanone on Si gel chromatography. The four sesquiterpenoids are very rare and have been sent for antimalarial testing .

5 . *Pachypodanthium staudtii* and *Cleistopholis patens*

Extracts of these two plants showed high activity in the antimalarial screen.

P. staudti **: CH_2Cl_2 : IC_{50} : 126.7 (D-6) ;138.6 (W-2)**
MeOH : 270.1 (D-6) ;474.1 (W-2)

C. patens **:.. CH_2Cl_2 : IC_{50} .. 7102.1 (D-6) ;14556 (W-2)**
MeOH : 2525 (D-6) ; 4371.9 (W-2)

Bulk collections and extraction of the two plants were made and the bulk extracts forwarded to University of Pittsburgh for isolation of active constituents.

6. *Enantia chlorantha* (Annonaceae)
Fractionation of the active MeOH extracts of *E. chlorantha* furnished a new protoberine alkaloid, derivative of palmatine alongside with palmatine, jattrorhizine and columbamine 5mg of **17** are available for anti-malarial evaluation.

Antileishmanial Test

Dorstenia poinsettifolia Engl (Moraceae) is a herbaceous annual used traditionally in the Korup region of Cameroon with *D. multiradinta* to treat skin diseases and infected. wounds. A preliminary study that the chalcones of *D. multiradiata* were responsible for activity in the *Leishmaniasis* screen in WRAIR. This encouraged us to undertake a detailed phytochemical study of *D. poinsettifolia.* A total of 10 flavonoids have been isolated from this species. Eight were submitted for the antileishmaniasial screen. The results are still awaited.

During the report period, 86 plant extracts were screened in different screening assays in use in our Nigerian Laboratory .The summary is as shown below :

Table A-2: NUMBER OF PLANT EXTRACTS SCREENED

ANTI-MICROBIAL SCREENING	35
MINIMUM INHIBITORY CONCENTRATION (MIC)	21
BRINE SHRIMP LETHALITY ASSAY	30

ANTI-MICROBIAL SCREENING

The anti microbial screening procedure involves first testing the plant extracts against the cultures of the test organisms at high concentrations of 2,000µg/ml and 5,000µg/ml .
The plant extracts showing activity at 2,000µg/ml were further evaluated to determine their minimum Inhibitory concentration (MIC) and Minimum Bactericidal Concentration(MBC) values against the test organisms .

The summary of the results for the 35 plant extracts are shown below in **Table A-3**:

Table A-3: Anti-Microbial Screening

Organisms	Activity Profile*
Staphylococcus aureus ATCC 12600)	19
Bacilus subtilis (ATCC 6051)	15
Pseudomonas aeruginosa (ATCC 10145)	4
Escherichia coli (ATCC 11775)	6
Candada albicans (ATCC18804)	1

* Number of plant extract with antimicobila activity.

8 plant extracts showed no activity

Table A-4: The Following Plant Extracts Showed Outstanding Anti-Microbial Activity Against The Organisms indicated at concentrations shown.

Plant Extracts	Test Organisms	MIC(µg/ml)
Picralima nitida Bse	B.*subtilis*	32
Picralima nitida Ase E_3	B.*subtilis*	250
Petersianthus macrocarpus Asb E4f	*B.subtilis ,P.aeruginosa*	125
P.macrocarpus Asb E4e	*P.aeruginosa*	*125*

Other plant extracts showed activity with MIC values ranging from 500µg/ml to 2,000µg/ml . No extract with outstanding antifungal activity against the yeast in our screening system was found.

BRINE SHRIMP LETHALITY ASSAY

The results for the Brine Shrimp Lethality assay are shown below . The LD_{50} with 95% confidence limit (C.L) are indicated .

Table A-5:

	Plant Extracts	**LD_{50}.**	**95% C L**
1.	Pyrecantha staudtii B.le / st E4b	*	
2.	Pyrecantha staudtii B.le/ st e4	*	
3.	Picralima nitida B.se Esa	62.27	36.65-103.85
4.	Picralima nitida A. Se E4	19.73	5.31 - 43.03
5.	Picralima nitida A Se E1	38.54	24.20 - 60.96
6.	Petersianthus macrocarpus A. sb. E4d	235.07	112.74 - 869.87
7.	P. macrocarpus A.sb Esa	869.87	533.18 - 869.87
8.	P. macrocarpus Asb E4	987.10	481.33 - 4048.41
9.	Prosopis africana A. rb E4d	171.24	115.09 - 269.21
10.	Prosopis africana A.rb E4f	409.89	.337.76 - 487.75
11.	Prosopis afrticana A. rb Esa	2351.04	1029.60 - 59224.67
12.	Buchholzia coriacea B.seE4	*	
13.	Prosopis africana A.rb.E4e	137.12	82.90 - 223.40
14.	Prosopis africana A.rb.E4	273.54	199.35 - 330..99
15.	Picralima nitida B.se E4c	7190.19	
16.	Gongronema latifolia A.le/st Esa	25.77	15.54 - 41.53

17.	G. latifolia A.le/st E4	11.60	0.02 - 126.91
18.	Pyrenacantha staudtii B. le/st E4 a1	774.05	577.08 - 1375.22
19.	P. staudtii B. le/st Esa	123.70	0.00 - 261.31
20.	Petersianthus macrocarpus A .sb. Esc	127.40	46.23 - 402.52
21.	Picralima nitida B.se E4 a2	5.77	0.50 - 14.67
22.	Gongronema latifolia A. le/st E4 a1	6.48.46	553.44 - 769.81
23.	Gongronema latifolia A. le/st E4 a2	11.26	3.56 - 21.35
24.	Uvaria chamae Root CH3OH	10.84	3.66 - 19.83
25.	Boerhavia diffusa CH_3OH	310.87	179.56 - 597.34
26.	Detarium stem bark CH_3OH	140.01	91.81 - 222.26
27.	Ritchea Capparoides Root CH_2cl_2	*	
28.	Moringa oleifera leaves/stem CH_2Cl_2	*	
29.	Enantia chloronta bark CH_2OH	*	
30.	Lophira lanceolata CH_2Cl_2	2.43	0.01 - 2.43

*These plant extracts have been tested at two different concentration ranges with evidence of high activity. They will need to be tested further at much lower concentration ranges before LD_{50} values can be calculated.

At the University of Pittsburg, fractionation is being done on two of the ICBG selected plants namely; *Pachypodanthium staudtii* and *Cleistopholis staudtii* (Table A-6). A total of 58 bioassay- guided fractions have been tested against two clones of *Plasmodium falciparum* (D6 and W2). All the fractions were active against both clones of *Plasmodium falciparum* . However fractions from *P. staudtii* were more active with the least IC_{50} values of 23.99ng/ml (D-6) and 9.29ng/ml (W-2). Further analysis of the results showed that about 29% of the fraction had IC_{50} values 300ng/ml or less for both clones. Further bioassay directed fractionation is continued on the active fractions in order to isolate the active antimalarial compounds.

Table A-6 :

Plant Extract	Number of tested Fractions	Results
Pachypodanthium staudtii	47	+++
Cleistopholis staudtii	11	+++
TOTAL	58	

+++ = active

6-F. DRUG DEVELOPMENT :

Plant collection and extraction was done for different therapeutic classes. Our inventory showed that the following samples had been submitted at our testing laboratories in WRAIR, University of Utah, Southern Research Institute, Haskin laboratory at Pace University and National Institute for Allergy and Infectious Diseases. Following is a summary of samples submitted for testing :

Table A-7 :

DISEASES	SAMPLES TESTED	LABORATORY	LEADS
Malaria	490	WRAIR	20
Leishmania	130	WRAIR	6
Cytotoxicity	20	University of Utah	5
Viral	30	Southern Research Institute	2
Trypanosomiasis	27	PACE University	3

Trichomonas	25	PACE University	7
Opportunistic infection:			
Cryptosporidium	22	NIAID	2
Toxoplasmosis	22	NIAID	2

6-G. PHYTOMEDICINE DEVELOPMENT:

The International Center for Ethnomedicine and Drug Development (InterCEDD) will coordinate all phytomedicine development project in collaboration with ICBG, the University of Jos and the African Scientific Cooperation on Phytomedicine and Aromatic Plants (ASCOPAP). The output from this aspect of the proposal must meet the World Health Organization's guidelines and specifications for the preparation of phytomedicines. The project will be carried out in interdependent modules that will be based in several institutions. The determination of optimum product quality, technological requirements for processing and manufacture of the dosage form, the safety and efficacy testing will be conducted at InterCEDD; and the final determination of efficacy using the WHO protocol will be arranged through the ASCOPAP network to ensure a multi-center validation of results. WHO, IMEA and ISO norms for the control of starting materials, excipients and final dosage forms will be strongly adhered to. The objective is to standardize existing traditional remedies with clearly demonstrated safety and efficacy profiles.

6-H. INFRASTRUCTURAL AND CAPACITY BUILDING:

i) International Center for Ethnomedicine and Drug Development (InterCEDD):

The ICBG was instrumental to the establishment of this Center. Laboratory equipment was purchased. The capabilities of InterCEDD include processing and standardization of phytomedicine as well as maintaining a full herbarium and Ethnobotanical database. It serves as an answer to the dialogue being held over the years on standardization of African herbal medicines and thus is open to both local and international scientists as well as herbalists/ traditional doctors. In this Center, extraction of selected medicinal plants, initial bioassay screens of extracts and bulk extraction of plant material for drug development is performed. The Center also maintains an extract bank which incorporates inventory of the extracts, their distribution and their status in the test systems. Brine Shrimp lethality bioassays, Potato disc assays, Bioassay-guided fractionation, Chromatographic techniques, Isolation of compounds, Spectra studies and Chemical analysis are also performed in the laboratory. This Center has a staff of fifteen.

Purchase of pertinent equipment was also done at the ICBG laboratory at the University of Dschang, Cameroon during the period under review. These include circulating pumps, computer hardware, rotary evaporator.

ii) Training:

Two Ph.D. students supported by the grant since 1995 and working on Cameroonian medicinal spices, have defended their theses. Miss Marguerite Tchuendem worked on two *Aframomum* species which have yielded two anti-malarial active compounds. She is now engaged as a post-doctoral fellow in the Project. Dr. Appolinaire Tsopmo, the second student, worked on *Pentadiplanda* and some *Dorstenia* species.

The following workshops were organized by Bioresources Development and Conservation Programme in this report period:

Workshop on Bioprospecting and strategies for Industrial Exploitation of Medicinal and Aromatic Plants:

This workshop was held in conjuction with the International Center for Science and High Technology (ICS), an autonomous institution within the framework of the United Nations Industrial Development Organization (UNIDO). It was held in Enugu, Nigeria on September 22-27, 1997. The workshop objective was to train mid-level scientists and private sector managers on the key elements in establishing bioprospecting programs. This meeting provided a forum for interdisciplinary discussion on in-country research methodologies, cooperative agreements (involving capacity building, collaboration and partnerships and strategic alliances), transfer of appropriate technology and product development as well as sustainable sources of raw material, benefit sharing agreements and policy issues on ownership and access of genetic materials. Country reports and projects from Cameroon, Ethiopia, Gambia, Ghana, Guinea, Kenya, Madagascar, Mali, Nigeria, South Africa, Uganda and U.S.A. were presented and discussed. The workshop, in its communiqué, recommended that the African ICBG model of bioprospecting including benefit sharing and commercial arrangements be studied during the process of developing national policies on conservation and sustainable utilization of biodiversity. The course was attended by 63 participants from twelve countries.

Workshop on Standardization and Regulation of Herbal Medicines:

This international workshop was sponsored by National Agency for Food and Drug Administration and Control (NAFDAC), Bioresources Development and Conservation Programme and West African Pharmaceutical Federation (WAPF). It was held in Abuja, Nigeria on 29-30 September, 1997. The workshop addressed criteria for evaluating the quality, safety and efficacy of herbal medicine. The workshop was attended by 200 participants and included government representatives, NGO's, regulatory authorities, pharmaceutical companies, traditional healer's associations and the media.

Conference on Phytomedicines Development: Botanical for South Africa the 21st Century:

This conference was organized in collaboration with the Drug Information Association; the African Scientific Cooperation on Phytomedicine and Aromatic Plants (ASCOPAP); the Medical Research Council (MRC), South Africa and the Foundation for Research Development (FRD). It was held in Cape Town, South Africa on February 24-26, 1998. Lectures were presented on Market opportunities for Botanicals in USA, Africa, Europe and Japan; Botanical quality (raw material, extraction/ standardization, dosage form design etc.); Regulatory issues; Intellectual Property rights; Sustainable sourcing of raw materials and Global issues on biodiversity. The conference was preceded by a tutorial on Preparing for a Visit from FDA in which the importance of partnership, training and education, inspectional procedures, selection of sites, effective monitoring, compliance with regulatory requirements and effective communications were reiterated.

Workshop on Management of Bioprospecting:

This workshop was held in Accra, Ghana in conjunction with the Ghanaian Ministry of Environment, Science and Technology and the Department of Botany, University of Ghana, Legon. It focused on national policies regarding bioprospecting in Ghana, including conservation, ownership of genetic resources, benefit sharing, value adding and plant collection.

Economic valuation workshops:

Two wokshops on Socio-economic valuation were held in Nigeria. The aim of the workshops was to map out strategies for studies in the project sites and was attended by field staff from Nigeria and Cameroon. ICBG has also encouraged and promoted the establishment and maintenance of Community Farms in local communities for conservation of biodiversity. We have also promoted the formation of Union of healers in both Nigeria and Cameroon.

ICBG also sponsored participants to other meetings and workshops in the areas of Biodiversity Conservation (CBD Conference of Parties in Bueno Aires, Smithsonain field training courses in Zaire); Drug Development (United Nations workshop on Herbal Medicines in Hawaii, Phillipines, Spain, India and Panama) and Sustainable development. (See list of workshops in Attachment).

This ICBG was instrumental in the making of the World Bank video documentary on Phytomedicine and Nature Pharmacy. This documentary featured ICBG projects in Nigeria and serves as an educational tool.

iii) Trust Fund:

In a landmark occasion, the Board of Management for the Fund for Integrated Rural Development and Traditional Medicine (FIRD-TM) was inaugurated in Abuja, Nigeria on September 30, 1997. The Board, which consists of eminent personalities in Nigerian private and public sectors and heads of traditional healers' association in each particular community, is completely independent and will manage the Fund in accordance with its charter. The principal objectives of the Fund were outlined as including:

1. serving as the channel through which the benefit and economic rewards are distributed to the areas from which source plants for drug and other product development are found and also compensate individuals, rural communities and relevant local institutions;
2. applying part of the fund available to it to such projects or venture that will promote conservation of biodiversity, drug development and traditional medical practices;
3. seeking to improve the standard of living of families in target areas through community development initiatives, information, education and communication, and to mobilise volunteer efforts of the rural people towards improving themselves, their environment and ensuring sustainable utilization of the biological resources within their locality and sphere of control.
4. obtaining and channeling support and assistance to rural families, particularly women and children.

It is expected that in carrying out its objectives, the Board of Management will consult and collaborate with village heads and professional guild of healers in determining the nature of compensation to apply or projects to embark upon in any given locality. In executing its mandate, priority is to be given to such projects and activities that promote or encourage biodiversity conservation. They cannot, however, participate directly in the execution of selected projects, but shall provide the appropriate funding and supervisory presence to ensure its proper execution. The Board will act independently of any control by either BDCP or any donors to the Fund, but may work in close collaboration with them.

The Fund is constituted of three principal organs

1. The Board of Trustee
2. The Board of Management
3. The Advisory Board.

The Board of Management is the executive/administrative organ of the Fund and will act on behalf of the Fund in respect of all matters within the capacity of the Fund. The Board of Trustees is established in accordance with the requirements of the law and all the property of the Fund is legally vested in them, which they shall hold on trust. The Advisory Board which consists of distinguished

experts in areas that are related to the objects of the Fund as well as eminent leaders and individuals who identify with and can contribute positively to the fulfillment of those objects.

This Trust fund has received significant support from Shaman Pharmaceuticals Inc., Healing Forest Conservancy and some pharmaceuticals companies in Nigeria.

iv) Biodiversity Development Institute of Nigeria:

This ICBG was instrumental in the establishment of the Biodiversity Development Institute of Nigeria (BioDin) in collaboration with BDCP and the National Agency for Science and Engineering Infrastructure (NASENI). The main objectives of the Institute will be to promote sustainable utilization of biological resources and conservation of the environment through research, bioprospecting, inventory, training and information management. It will serve as a clearing house for the sustainable utilization of the national bioresources and facilitate the development of the necessary specialist skill and framework to provide a common multidisciplinary network of people with a wide range of interest. BioDin, which is an independent, self-sustaining, not-for-profit organization, comprises of three divisions: Division of Biodiversity Prospecting; Information Management and General Administration. The activities will include building up of reference information on scientific and technical expertise needed for research, negotiations and information management as well as enlightening the general public on biodiversity issues.

6-I. Computerized Information System on African Medicinal and Aromatic Plants

Computerized Information System on African Medicinal and Aromatic Plants (CISAMAP) is a relational information system on African medicinal plants. This is a network of databases linking sub-Saharan Africa. This database consists of Afrimed which is a database of medicinal (uses, constituents, pharmacology, literature), floristic (nomenclature, morphology, distribution and literature) and horticultural (propagation, cultivation, literature) plants. CISAMAP links West and Central Africa interactively and network with Pretoria (Southern Africa) and Nairobi (East Africa). The project will be fully functional by the fifth year of the ICBG.

6-J. SOCIO-ECONOMIC VALUATION OF PLANT SPECIES:

The inability of local users and authorities to recognize or commensurately value the functions and services of tropical forests has for long constrained conservation, efficient use and sustainable management of biodiversity. As a result the total economic value of forest resources as reflected in official documents and publications rarely influences decisions bordering on their exploitation and managment. Yet there is apparent failure on the part of local authorities to put in place appropriate mechanisms that would engender efficient and sustainable management of forest resources and influence management decisions in the right direction. In spite of the economic importance of non-timber forest products (NTFPs) less attention has been given to NTFPs than wood production in its various forms. However, there is now a growing tendency to acknowledge that for any resource to be more sustaintably managed, the cost of using the resource should reflect the total value that society places upon it. This is important for planning at the macroeconomic level and to demonstrate the necessity to make efficient allocative decisions at the microeconomic level.

To assess the total value of non-timber forest resources to indigenous communities survey data was obtained in 1997 from a sample of households in two local government areas of Ebonyi and Imo States of Nigeria. A total of 300 households who lived on the fringes of forests and relied on forest resources for most of their consumption goods and their general well-being, were interviewed for the study. Survey results indicate strong manifestation of the diverse functions of forests which directly or indirectely contribute to the welfare of local people, including food security. A variety of fruits, vegetables, herbs and many other flora which households exploit, were identified. Ranking high in

importance is the medicinal value of plants, derived mainly from their roots and leaves. The study identified many common medicinal plants. Ranking of these revealed those plants which were more highly valued by the respondents such as strophanthus hispidus, Nauclea sp., Vernonia sp., Rauwolfia vomitoria Piptadeniastrum africanum, albizia sp., etc.

There was strong indication that incomes from NTFPs account for a significant proportion of household income. The average values of ₦7240, ₦12,269,5 and ₦16,270,43 estimated for 1994, 1995 and 1996 represented 47%, 80% and 94% of total income from minor sources.
It was revealed that although medicinal plants were ranked highly in importance, they did not yield much in terms of income as compared with the income realized from sale of other forest products. This reflects the extent of commercialization of medicinal plants. There was no evidence of linkages with distant or across-border markets as most of the commercialized medicinal plants are normally sold or administered locally.

Non-market values of plants species were estimated. The willingness to accept as compensation (WTA) estimates per unit of medicinal species was found to range from as low as ₦20 to as high as ₦2,471.92. However this was lower than what an average herbalist was willing to accept. The willingness-to-pay (WTA) estimates in respect of specific forest areas ranged from ₦3,000 to ₦6.5 million, with an average of ₦434,738.46. These represent the amounts which the respondents were willing to pay in order to ensure the protection of community forests. Similar estimates for specific NTFPs ranged between ₦100 and ₦30,278.79.

Willingness to accept (WTA) as compensation estimates in the way of compensation for forest degradations and destruction showed that respondents were willing to accept an average of ₦155,600.41 for specific forest products. The highest amount of ₦1.69 m was recorded in respect of Indian bamboo which was highly demanded for construction purposes. As expected, the WTA estimates for specific forest areas averaged about ₦1.5 m. The lower values obtained for WTA estimates have been attributed to several behavioral and psychological reasons.

Many of the finished products derived from the forests investigated were found to command considerable commercial value in local markets. In spite of data limitations this study has resulted in a reasonable assessment of the economic value of NTFPs to indigenous people. It is hoped that the information contained will help relevant authorities take decisions on

(i) conservation of tropical genetic resources as a means of improving rural economies
(ii) improving the welfare of indigenous populations
(iii) enabling local people raise their incomes by monitoring the sustainable economic utilization of forest resources
(iv) mobilizing local people to protect the resource base in their own communities
(v) providing policy analysts with data on non-market value of forest resources in addition to commercial value.

To sustain conservation practices among indigenous populations, it is necessary that pharmaceutical industry based on tropical forest-related drugs should be made to ensure that a significant proportion of their revenues or benefits is returned to the indigenous communities. It is also recommended that since forest management policies are shaped through a convergence of institutional interests among resource users, stakeholders, communities, local government, national government and international agencies, a convergence of these interests should be advocated in any effort to ensure sustainable managment of forests.

Background and Justification

Forest could be described as a kind of vegetation consisting predominantly of woody plants (trees, shrubs, herbs and climbers)and from which grasses are almost absent (Hopkins 1974). Tropical forests, consisting of dry and moist forests, are regarded as the most complex of vegetations while tropical rain forests, covering about two-thirds of all tropical moist forest, are considered the richest in biological diversity and constitute the major emphasis of global community with respect to deforestation (Munasinghe and Sharma, 1995).

It has been estimated that between 1850 and 1980 tropical Africa has lost 20 percent, Southern Asia lost 43 percent, and Latin America has lost 19 percent of existing forest cover (Rowe, Sharma and Browder, 1992). Since this assessment, annual loss of tropical forests has not decreased. A more recent assessment put the estimated annual loss of tropical forests during the late 1980s at 16.9 million hectares, which was higher than 11.3 million hectares recorded in the early 1980s (FAO 1992 cited in Munasinghe and Sharma, 1995). The implication is that population explotion and the corresponding increase in the pressure on forest resources have taken their toll on the ecosystems.

Succinctly summarized, tropical forests

(1) Are the homeland of many indigenous people.
(2) Provide a habitat for the variety of life forms (biological diversity).
(3) Are sources of raw materials and invaluable in terms of contribution to food security, household articles, medicine, income, culture and religion.
(4) Provide ecotourism and a sink for waste and human residue.
(5) Protect watershed (Pearce and Warford, 1993; Munasinghe, 1992).

One of the factors constraining conservation, efficient use and sustainable management of biodiversity is the inability of users to recognize or commensurately value the functions and services rendered by such natural endowments. Because the benefits of natural systems are unappreciated and grossly undervalued their total economic value as reflected in official documents and publications rarely influences decisions bordering on their exploitation and management. Yet there is apparent failure on the part of relevant authorities to put in place appropriate mechanisms that would engender efficient natural resources management and influence management decisions in the right direction.

Although, historically, indigenous populations have exploited non-timber products from tropical forests for many centuries, less attention has been given to non-timber forest products (NTPFs), than wood production in its different forms. However, there is now a growing tendency to acknowledge the total value of natural ecosystems, including tropical forests. It is widely acknowledged that for any resource to be more efficiently managed, the cost of using the resource needs to reflect the total value society places upon it. According to the report of subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) of the convention of Biological Diversity, failure to properly value resources means that incorrect signal are sent to decision-makers, conveying in turn, misleading information about the resources scarcity and thus provide inadequate incentives for the management, efficient utilization and enhancement of biological resources• .

It follows from the above therefore that economic valuation of NTFPs is important from two points of view, namely: to show that NTFPs also matter for planning at the microeconomic level and to demonstrate its necessity in making efficient allocative decisions at the microeconomic level.

Utilization and Conservation of Non-timber Forest Products

With about 216,634,000 hectares of closed forest areas, Africa is blessed with abundant biological resources. But the management of these resources has remained a nagging issue facing resource economists, scientists and policy makers. This is because, in spite of its enormous biological resources, the continent has continued to lag behind in almost all socioeconomic parameters. Although many factors are responsible for this sordid situation, it is generally believed that the adoption of inappropriate resource management strategies is a key factor in the declining standard of living in many parts of Africa. Allied to this is habitat destruction due to pressure on land to accommodate increased industrial demand of cash crops in place of subsistence farming (Iwu, 1996). Many species are now facing extinction as a result of pressures caused by increasing population, urbanisation, environmental degradation, deforestation, uncontrolled harvesting and lack of clear conservation policies (Abegaz, 1996). Furthermore, because of the need to fill the gaps in health needs arising from rapidly escalating prices of important drugs, there has been, of recent, unprecedented demand for medicinal plants. The major multinational pharmaceutical companies are not totally free from unsustainable collection of biological materials.

The market for natural product is huge, estimated at over $85 billion per annum. In 1994 alone the total global market for pharmaceuticals was US $240 billion and of this figure $50 billion was of plant origin, $25 billion was from processed plant extracts and about $10 billion was from tropical plant extracts (Iwu, 1997). This trend in global herbal trade places tropical Africa in a strategically favourable position to compete in an unsaturated international market. This, in our view, has presented the continent with an ample opportunity for a rapid socio-economic growth. It has also presented Africa with a unique opportunity to take stock of its biodiversity through proper valuation techniques. It is only by so doing that the correct signals could be sent to the relevant authorities for the provision of adequate incentives for sound resource management.

Internalizing Biodiversity Benefits and Costs

Result-oriented biodiversity conservation programmes in Africa should be based on the provision of a mechanism that will internalize the external benefits and costs associated with using genetic resources. This derives from the premise that a country seeking to accomplish a considerable level of sustainable biodiversity conservation, should of necessity, not divorce its benefits from the society. As Sittenfeld (1997) aptly puts it, "Persistence of diversity depends on the benefits obtained from it... use it or loose it". In countries where emphasis has been laid on this, it has been realized that there is even greater potential for future economic and intellectual value in biodiversity conservation than in more traditional farming (Sittenfeld, 1997).

The above view calls to mind the issue of adequate conpensation for source countries, communities, villages and individuals whose resources have been exploited. Often the question is what the owners of resources should justifiably receive in return for making their biological materials available for drug discovery investigations or for other products that can be commercialized (Abegaz, 1996). In this regard, Akubue (1997) argues that since the indigenous plants being used for the production of phytomedicine belong to the indigenous community in which they grow, commercial exploitation of the plants makes it mandatory that the community ought to benefit from the use of the plants. In that case, it does not really matter if the plant in question has any commercial value to the people or not. A notable demonstration of this approach could be gleaned from the activities of the International Cooperative Biodiversity Group (ICBG) which has adopted a framework for reciprocity and equitable distribution of benefits from biodiversity that includes:

i. short term and intermediate compensation
ii. long term benefits/royalty payments and
iii. training and capacity building.

In summary, the main focus of the African ICBG project is the establishment of an integrated program for the discovery of biologically active plants for drug development and biodiversity conservation, while ensuring that local communities and source countries derive maximum benefits for their biological resources and their intellectual contribution (Iwu, 1996).

The decline in importance of many African cash crops within a single decade is a pointer to the warning that African nations should not slip into the mistakes of the 1950s when they were involved in commodity trade with European countries through an arrangement which placed many African nations in a great disadvantage . To a large extent, the Europeans placed themselves in a vantage position of determining the prices they were willing to pay for the raw commodities, and yet also enjoy the privilege of controlling the price they would accept for the processed goods (Iwu, 1996).

It is our view that economic valuation of plant species will generate data which will provide valuable information that will enable countries, local communities and companies to more effectively engage in trade of valuable local species, in a manner which contributes to sustainable development and conservation of biodiversity.

OBJECTIVES

This research project has the objective of assessing the value of forest resources to indigenous populations and communities that live on the fringes of forests and rely on forest resources for most of their consumption goods and their general well-being. Specifically, this component evaluates the exploitation and uses of various plant species and other forest products in the communities studied; assesses knowledge levels of forest users concerning medicinal plants and other forest products; determines the marketable and non-marketable values of plant species, and using contingent valuation method, assess the value that indigenes place on rain forest protection. The project aims to create participatory conditions that increase the ability of the forest dweller and rural communities to generate, access, comprehend and creatively use appropriate and relevant technologies and marketing tools to sustainable use forest resources to meet their basic needs and at the same time conserve biodiversity. The communities (especially women and the youth) were involved through participation in information gathering, consultation at all stages of the project's implementation, decision making, project development and participatory internal evaluation.

THEORETICAL FRAMEWORK

Conceptual Problem of Value

Different groups have different perspectives of ecosystem values. Misconceptions arising from the diverse views often result in dispute among the various groups concerned with ecosystem values and functions. A case in point is the value perspectives of ecologists and economists who are both concerned with ecosystems and their role in sustaining human welfare. According to Farnsworth, Tidrich and Jordan (1981), the misinterpretation of connotations in terminology and specialized jargon often results in ambiguity and conflict. While the economist is usually interested in the value of goods and services in monetary terms using private market transactions, the ecologist (in addition to the economists concept of value) refers to value in intangible terms, including the value inherent in the ecosystem such as protecting watersheds, acting as a store and fixing of carbon dioxide, etc. It is now conventional to approach the issue of environmental resource valuation from both the economic and ecological perspectives.

Economic Valuation of environmental resources

Combining the two perspectives highlighted above we can divide total economic value into use value (or instrumental value) and non-use value (or intrinsic value).

Use or Instrumental Value: It is conventional in literature to describe Use or Instrumental values as the capacity of an environmental asset to satisfy current production or consumption needs. Use value can be further divided into direct use value (DUV), indirect use value (IUV) and option value (OV). Direct Use value is derived from output that are consumed directly. It can be measured by the contribution of an environmental asset to satisfy current production or consumption (Kramer, Sharma and Manasinghe, 1995). Although direct use value is easy to conceptualise, it may not necessarily be easy to evaluate in economic terms.

Pearce and Warford (1993) illustrate this point with the yield of some forest product which can be measured using market and survey data while the value of medicinal plants is more difficult to measure. Generally direct use values could be categorised into timber and nontimber uses. Nontimber products can be grouped into three major categories: (1) fruits and seeds, (2) plant exudates (e.g. latexes, gums and resins), and (3) vegetable structures (e.g.. Stems, leaves, roots, barks, and buds). (Peters, 1994). Indirect value refers to the value associated with the ecologist• s ecosystem services supporting economic activities. These include such environmental functional services as watershed effects, carbon cycling and greenhouse effects.

Option value may refer to the amount (as in insurance premium) consumers are willing to pay for an unusual environmental asset for the option of its conservation for future use. It includes both future direct and indirect use values. Existence value refers to the satisfaction derived from the mere knowledge that an environmental asset exists even though the individual does not intend to use it now or in the future.

Bequest value relates to the value that individuals derive from the knowledge that the future generation will be able to benefit from an environmental asset in the future. Also available in literature is the concept of Quasi-option value which is the value of information that arises after the decision has been made to conserve or develop an environmental asset now. It is the value of learning about the future benefits that could be precluded if development option were chosen now.

Concept of Total Economic Value (TEV)

The concept of Total Economic Value (TEV) has also been identified in literature (Pearce and Warford, 1993; Kramer, Sharma and Munasinghe, 1995). Conceptually, the components of total economic value of an environmental resource are made up of its (1) use value (UV) and (2) non-use value (NUV). Use values consist of direct use value (DUV), indirect use value (IUV) and option value (OV). Nonuse value can be further categorised as existence value (EV) and, sometimes, bequest value.

Using symbols we may express the conceptual relationship as

$$TEV = UV + NUV:$$

Since $UV = (DUV + IUV + OV)$ we may therefore write.

$$TEV = (DUV + IUV + OV) + NUV.$$

In reality, simply aggregating the components of TEV may lead to double counting, especially if the components are mutually exclusive. In spite of its potential for ambiguity and overlapping, the TEV concept is regarded as a good guide in the evaluation of economic value. According to Kramer, Sharma and Munasinghe, (1995), since the basic objective is to measure TEV, there is less emphasis on the distinction between individual component of value, which are considered primarily as an indicative guide.

Techniques of Valuation

Many quantitative techniques of environmental evaluation are evolving rapidly. However, the results arising from such techniques have been controversial and call for caution in their use. Also, the application of techniques of environmental valuation to developing world has been limited as a result of limited information flow and imperfect functioning of markets. In spite of these obstacles, it can be gleaned from evolving literature on environmental economics of developing world that some of the techniques are relevant and can be applied (Bartelmus, 1986; Bojo, Maler and Uremo, 1990; Pearce, Babier and Markandya, 1990; Pearce and Warford, 1993).

Direct Valuation of environmental resources

Many empirical techniques can be employed to quantify the concepts of value highlighted above.

Market Valuation Approach

Bartelmus, Lutz and Tongeren (1993) present techniques for estimating the market price/value of depletable natural resources.

(I) Discounted (present) value method

The market value of natural assets is obtained by using the prices of the asset extracted or service provided as the future sales value, reduced by the exploitation costs. (Net return).
The present value V_o of the resource is the sum of the expected net revenue flows
$N_t Q_t$ discounted at nominal or real interest rates for the life T of the resource.
where N = the total unit value of the resource
Less the costs of extraction, development and exploration and
Q_t = the quantity exploited over the period t.

The difficulty in this method lies in estimating future returns and costs of natural resource exploitation, as estimates would require information on availability of future stocks, prices and interest rates.

(ii) Net - price method

The net-price method neglects future (discounted) losses of net returns The value of a natural resource is calculated as the product of the quantity of the resource stock and the net price.Vt = (Pt-Ct)Rt =NtRt Where

V_t = value of the resource at the beginning of period t

R_t = volume of stock

P_t = market value per unit of the resource

C_t = market value per unit (marginal) cost of extraction, development and exploration

N_t = difference between P_t and C_t .

It follows from the above that the net price of the resource is the actual market price minus its marginal exploitation costs including a normal rate of return.

(iii) Depletion of stock method.

This method estimates user-cost allowance as the difference between the values of the stock at the beginning and the end of the accounting period. An alternative approach which focuses on potential income generated from extraction (sales) has been proposed (EL serafy,1989). If R is the annual net revenue from the sales of the resource, assumed to be constant over its lifetime (of

n years), a true income element X can be calculated such that R-X represents a capital element whose accumulated invested at an interest rate r during the n years would create a permanent stream of income X (per annum) and the user cost which is the discounted (last) net revenue.

The basic idea in the above method is to convert a time-bound stream of (net) revenues from the sales of an exhaustible natural resource into a permanent income stream by investing a part of the revenues (user-cost allowance) over a life time of the resource, while only the remaining amount of the revenue should be considered (El-serafy, 1989). However, the problem here also lies in the difficulty in choosing r. It also fails to address the role (availability and consumption) of natural assets in particular production processes, that is their sustainability.

Harou, Kjorven and Dixon (1996) note that using direct proxies to estimate values of environmental impact involve costs and price information which approximate values of environmental externalities, are easily observable, but rarely reflect the benefits of environmental improvements or the damages from degradation. Included in the list of directly observable costs or prices therefore are the loss of agriculture productivity (productivity loss), the cost of medical expenditure (cost of illness), the cost of an ill person or premature death (human capital loss), the cost of averting or mitigating negative environmental impacts (response cost), the cost of replacing environmental goods or services (replacement costs), the cost of an aid project such as grants, debt - for-nature swaps, subsidized loans or donations, (aid costs, the reconstruction of an environmental good (shadow project), the cost per unit of output (cost-price) or the price of a close substitute. (cf also Munasinghe and Lutz,).

Valuation using indirect proxies

Indirect proxies are derived from observed markets, or behaviour in markets which are related to the environmental commodity. Thus people's preferences for environmental goods and services could be established by evaluating the prices they pay, or the benefits they derive from such goods and services in closely - related markets. Indirect proxies involve implicit (or surrogate) markets and include the value of an environmental asset (hedonic price) or job (wage) differential, or the time and cost incurred in visiting and enjoying a national park (travel cost) or marketed goods as surrogates for unmarketed goods.

- value of an environmental asset (property value)

This technique, also known as hedonic price technique, is anchored on the value of land approach. It is based on the idea that environmental quality affects the decision to purchase a particular land or house and the price of the property is determined by the environmental attributes of the property. Following Pearce and Warford (1993), the price of the property, H_P, is dependent on site variables, S, accessibility, A, neighbourhood characteristics, N, and environmental lack of quality, Q, Then.

$$Hp = f(S, A, N, Q)$$

$$\text{Thus } \ln Hp = a(\ln.S) + b(\ln.A) + c(\ln. N.) + d(\ln.Q)$$

we can therefore estimate directly the effect of Q on Hp independent of the absolute levels of Q and Hp.

The Marginal willingness to pay in order to reduce Q is then

Going a step further we can regress w on a set of household characteristics, such as family size, income and environmental quality.

$$w = g(H,Q).$$

The hedonic property approach has been used to analyze the effects of air pollution in specific areas. (Munasinghe and Lutz,) and can only be used if the market is competitive.

- Job (wage) differential

The hedonic wage differential technique uses a surrogate market (ie Labour market) to value risks to life and limb. The theoretical assumption is that a higher wage is needed to attract workers to high areas (e.g. highly polluted or crime infested areas) or to engage in more risky occupations.
From this we can establish a regression of the form.
W= W (S, I, J)
where S stands for site specific variables such as air pollution and crime; I refers to individual - specific variables such as race, sex, education and job experience; and J stands for job-specific variables such as injury rates. A more detailed analysis of hedonic wage models is found in Viscui (1986).

Travel Cost Method
This type of surrogate markets technique measures the expenditures made by travellers on recreation sites (parts, lake, forests) as the surrogate market. Hanley (1989) used this method to value travel time in projects dealing with fuelwood and water collection.

Market goods as proxies for non-marketed goods
This involves approximating the value of an environmental good by the observed market price of its substitutes. Babier et al. (1991) cites the example of valuing a non marketed fish variety at the price of the most similar fish being sold in local markets.

METHODOLOGY AND NATURE OF DATA

In order to evaluate the exploitation and uses of various plant species amd other non-timber forest products, assess knowledge levels of forest users, determine marketable and non-marketable values of products and assess the total value of forest, a survey was conducted of 300 households in 2 local government areas of Ebonyi and Imo States. Following a reconnaisance visit to the communities, structured questionnaires were designed to elicit information in the following areas:

(i) Household characteristics
(ii) Products/plants species usually collected from community forests.
(iii) Revenue generated from forest products
(iv) Gender issues in respect of assess to and use of forest products.
(v) Knowledge of plant species
(vi) Marketable and non-marketable values of plant species, etc.

Data on specific forest products were generated with respect to product type, usual period of collection, quantity, price of product. The revenue generated from harvesting medicinal plants was established by using primary data obtained in the household survey. Specifically, information was sought with respect to the species, plant part collected, period of collection, frequency of collection, quantity, price and market sold. These were also estimated for non-marketable medicinal plants.

The final section used the contigent valuation method. The questions referred to how much the respondents would be willing to accept as compensation if the government decided to clear community forest for a project.

RESULTS AND DISCUSSION

Household Profile
The household survey convered a total of 15 villages, 3 communities, 2 Local Government areas in Ebonyi and Imo States, all located in the Southeastern Nigeria. The total population covered

by the household survey is about 300, comprising 248 males and 52 females. Majority of the respondents were in the age bracket of 41-50 while only about 21% and 29% were in their 30s and above 60, respectively. Most of those surveyed (77.6%) were illiterates who had no formal education. The rest who had attained various levels of education comprised retirees who had back-migrated to their communities. As is typical in rural areas of Nigeria, slightly more than two-thirds of the respomdemts had farming as their major occupation. Other major occupations were traditional herbal practice, wine tapping, civil service, and trading. As expected too, many of the surveyed (36%) regarded farming as their secondary occupation, while about 10% were part-time herbalists. Trading, wine tapping, and hunting were also important secondary occupations in the communities investigated.

In 1996, the average household head reported total annual earnings of ₦22,942 and ₦15,280 from major and minor occupations, respectively (86 Nigerian naira = US $1). The model class was ₦10,000 - ₦15,000 and ₦5000-₦10,000 for major and minor occupations.

Exploitation and Use of NTFPs

Nearly all the respondents had access to community forests many of which were primary forests. More than three-quarters of the sample lived an average of 3km to a major forest area.

Table 1 summarises the uses to which forests are put.

Table 1: Major uses of Forests

Uses	No of Responses	%
Medicinal	158	43.3
Farming and other economic activities	144	39.9
Food and other forest products	46	12.6
Religion/Idol worship	6	1.6
Hunting	4	1.1
Political/Social	4	1.1
Water supply	3	0.8
Total	365	100

Source: Field survey, 1997

It is clear from responses in table 1 above that forests serve diverse functions to indigenous people in the communities surveyed. Of highest significance to the repondents is the perception that forests provide the habitat for biodiversity which are considered to have medicinal value. Following closely in importance is farming and other economic activities which take place in forest areas. Allied to these, is the value of forests as a source of food and other forest products such as fruit, nuts, latex, honey, rattan, meat and oils. Also notable, albeit with lower responses, were the use of forests as sources of water supply, religious, political and social activities.

Obviously, these are economic functions which directly or indirectly contribute to the welfare of the communities in which the forests are situated.

Non-Medicinal Uses

Tropical forests provide the habitat for extensive fauna and flora. Thus, an important aspect of the study was to identify those plant species which are commonly collected from community forests for non-medicinal uses. Table 2 depicts the variety of fruits, vegetables, herbs and other plant species which households exploit. Although the forest products play a significant role in the food security of most households, collection for the market was the predominant reason for collecting the products. Fruits ranked high among the NTFPs, most of which are consumed fresh or sold at local markets. Only a few products such as latex, mats and wraping materials (etere:Igbo) were sold at distant markets.

The importance of NTFPs to the communities could also be judged by the frequency of collection. A highly signficant proportion of the respondents (35.7%) indicated that they normally collect forest products daily while about 7% and 8% accounted for those who preferred weekly and monthly collection, repectively. Another noteworthy factor which attests to the significance of forest products is that both parents and children are involved in their collection. Most household heads who had been collecting forest products since infancy, did not see anything wrong in allowing their children to go to the forests.

Medicinal Uses:

Ranking high in importance is the medicinal value of forests. The common medicinal plants that were identified and compiled from interviews with traditional herbalists in the communities are listed in table 3. In addition, other medicinal plants commonly found in the study area are listed in tab 4. Roots and leaves of medicinal plants are more commonly used although in a few cases as in trees the bark is used also. A common practice among the herbalists interviewed is the use of a combination of plants to treat a specific ailment. However, the number and species combined for specific ailments were found to vary from one herbalist to the other and depended on knowledge levels of medicinal plants.

The respondents' ratings of their knowledge levels in respect of plants were high as indicated by about 47% of those surveyed. About 32% and 20% of the sample rated their knowledge of plants as medium and low, respectively. Most of the respondents claimed that the knowledge of plants was imparted to them by their parents or grand parents.

It is important to distinguish between a general knowledge of plant species and medicinal knowledge of plant species. Although in a general sense, rural dwellers have acquired some level of plant knowledge, this pales into insignificance when compared with knowledge levels and skills of traditional herbalists.

In addition to the respondents knowledge levels, the study sought to rank some of the identified species in their order of importance or value (Table 5). The exercise revealed a few of those medicinal and food plants which are highly ranked by the surveyed in the communities investigated. This is by no means comprehensive as the respondents failed to respond to many other species which, no doubt, are valuable. It is clear from the table that *strophanthus hispidus* (Igbo: Osisiaguru), *Nanclea* sp. (Igbo: Anuruagbo), *Vernonia* sp, *Rauvogia vomitorii* (Akata), *Piptadeniastrum africanum* (Uhi). *Albizia* sp. (Ngwu), were among those species ranking very high because of their medicinal value. So too were vernonia sp., Iroko, Ogbono (Irvingia gabonensis), Utazi (Gongronema latifolium), Uziza (Piper guineense), Akirilu (Garcina kola) and Udara (Chrysophyllum a which have both medicinal and food values.

Market benefits of non-wood forest products (non-medicinal)

The study distinguishes between income earned from food and medicinal plant species. This is however for analytical purposes since most species could be categorized as both medicinal and food plants. Table 6 is a summary of the amount in Naira realized from various forest products by an average user of each of the products between 1994 and 1996.

Except in a few cases, the data portray a nominal increase in the amount realized from sale of forest products by users between 1994 and 1996. Given the current harsh economic situation in the country, the evidence of increased sale of forest products resulting invariably from increased harvesting, may not be surprising. The high revenue accruing from such products as rubber and bamboo may be attributed to industial use of these products. It is also evident from the table that items which serve dual functions - medicinal and food - attract higher value per unit than single purpose products. In the former category belongs items such as Gongronema latifolium (utazi), Piper guineense (uziza), Garcina kola (bitter kola), Xylopia aethiopica (uda), etc.

The average values of ₦7240, ₦12,2679.5 and ₦16,270.43 estimated for 1994, 1995 and 1996, represented 47%, 80% and 94% of total income earned from minor sources, respectively. This tends to support the view that income from NTFPs acounts for a large share of household income. (Gunatileke, Senaratre and Abeygunawardena, 1993; Appasamy, 1993).

As household incomes become eroded by unfavourable exchange rates, the economic impotance of forests and their products relative to agriculture and allied activities begin to rise.

Income from Medicinal Plant Species

Data on income from medicinal plants (Table 7) reveal various amounts ranging widely from ₦20 to ₦8950. The mean value of about ₦ 1590.2 in 1996, pales into insignificance if compared with the amount realized from other forest products as shown in section 5.3. The meagre revenue estimated from medicinal plants reflects the occupational distribution of the respondents. Although a high proportion of those surveyed indicated reliance on plants for medicinal purposes, only about 10% were herbalists who commercialized medicinal plants and derived part of their income from them.

Some noteworthy medicinal plants which were valued higher than others include: *Albizia* sp (Ngwu); *Morinda indica* (Ugere), *Rauwolfia vomitoria* (Akata), *Costus afer*, (Okwete), *Piptadeniastrum africanum* (Uhi), Iroko, *Nauclea* sp (Ubulu), *Strophanthus hispidus* (OsisiKaguru), Uda, *Gnetum africana* (Ukazi) and many others which could not be identified.

Most of the commercialized medicinal plants are normally sold or administered to patients in the same or neighbouring locality. There was no evidence of linkages with distant or across-border markets. There were, however, many other plant species whose market values could not be quantified because they were neigther sold in the markets nor administered by traditional herbalists.

Non-market value of plant species.

An empirical effort is made in this section to measure the value of medicinal plants which are not exchanged in the markets and therefore, do not have any prices associated with them. Having first established the preference of the surveyed for such non-marketed plant species, the CVM

was eventually employed to obtain willingness to accept as compensation (WTA) estimates in respect of medicinal species.

Willingness to accept as compensation estimates

The willingness to accept as compensation (WTA) estimates per unit of medicinal specie was found to range from as low as ₦20 to as high as ₦8000. (Table 8). The amount the average respondent was willing to receive as compensation per medicinal plant in the forest was ₦2,471.92. This was by far less than ₦ 3793.75 which an average traditional herbalist was willing to accept as compensation per unit of medicinal plant. The reason for the discrepancy in these two WTA estimates are obvious: while the traditional herbalist earns income by using plant to treat patients, the average household head uses herbs domestically without attaching much value to them.

It was evident that the values attached to medicinal plants were dependent on commercial relationships and the nature and number of ailments that are associated with them. For instance the dual-purpose plants, especially those used as food and herbs, were found to be more highly valued than most single purpose plants. It is also pertinent to note that WTA estimates may be related to the seasonality of the plants in question. Some medicinal plants, shrubs in particular, are only available during the rainy season. Many of such plants were found domesticated on compound or backyard farms where their availability throughout the year is ensured. However, the exact nature of these relationships can only be established by a more quantitative evaluation.

Willingness-to-pay as compensation estimate (WTP).

Respondents were asked to express the amount they were willing-to-pay as compensation for specific forest areas on the one hand, and specific non-timber forest products on the other. The WTP estimate in respect of specific forests in the communities investigated ranged from ₦3000 t0 ₦6.5million, with an average of ₦434,738.46 (Table B-9). These represent the amounts which the respondents were willing to pay in order to ensure the protection of community forests. Expectedly, the willingness-to-pay as compensation estimates in respect of specific non-timber forest products were smaller, ranging between ₦100 and ₦.5million, with a mean value of ₦30,278.79. The implication was that an average user of forest products would be willing to pay ₦ 30,278.79 for the protection of a specific forest product.

Willingness-to-accept as compensation in the way of compensation for forest degradation. Another approach adopted to measure the economic value of forest resources to indigenous populations was to solicit for information on what they are willing to accept (WTA) in the way.

Table 9: WTP Estimates for Specific forests.

Community Forests	**WTP (₦)**
Umuoyim	10200
Mbaraocha	88000
Ofeiyi	6000
Ohia Emedo	3000
Ikpa-alaika	5000

Oke-Oha	4000
Okeohia Umunze	16000
Ekpezize	84000
Okeohia-Ofukpa	30000
Epenwaopara	20000
Ofeikpa	20000
Epe Ikpem	60000
Epe imo	30000
Onuagu	22000
Aleke	22000
Okeohia-osineke	112000
Alajerya	99000
Ude Otukpo	200000
Ajaohia umuduruokoro	6.5millio
Okeohia onudimgo	2.5million
Ajaohia Ibeabuehi	200000
Ajoohia Okoronkwo	22000
Osisifiyofiyo	800000
Owereukwu	250000
Agambo ogara	100000
Ekwe okwu	100000
Total	11303200

of compensation for forest area degration and destruction of specific non-tmber products. The WTA estimates for specific products ranged from ₦300 to ₦1.69million. Highly valued plants such as Utazi, Gnetum africana(ukazi), uziza, Irvingia gabonensis (Ugiri), Chrysophyllum albiduim, and Indian Bambo were estimated at ₦423,200.00, ₦1,690,900, ₦140,950, ₦893,800.00 and ₦1,226,000.00 respectively. The highest amount (₦1.69m) recorded in respect of Indian bambo could be attributed to its industrial use as construction material. The WTP values for specific forest areas were found to range between ₦22,000 and ₦7million. The mean value was ₦1,521,161.29 . Our data show that WTA compensation for being deprived of forest services yields higher values than corresponding WTP estimates to retain the same natural resources. This discrepancy has been attributed to several behavioural and psychological explanations. One is that people are less willing to spend actual income or wealth as opposed to "opportunity" income or wealth, defined as money they do not yet have but may obtain (Knetsch

and Sinden, 1984). Another reason is that people may exercise more caution "about changing the status of assets as opposed to experiencing no change". (Kramer Sharma and Munasinghe, 1995). The use of WTA in this study is justified on the grounds that WTP estimates are grossly influenced by income levels in the rural areas. As incomes are low in the communities investigated, the tendency for respondents to undervalue forest resources are high. This, invariably, affects WTP values.

Finished Products:

Tropical forests provide essential raw materials and inputs that support assorted rural enterprises and provide employment to large segments of rural population. Extractives such as oil palm-wine and raffia palm wine are common products in the forests investigated. Many of the finished products from forest based enterprises have considereable commercial values in local and international markets. The list of handicrafts and other products of value made from forest materials are presented in Table 10. The system of handicraft production in the areas of study can be described as traditional in the sense that it is based on methods which have been in operation for generations. Most of the products were derived from oil palm and raffia palm trees, most of which are old and of dwindling productivity. Evidence showed that the exploiters had no links with markets outside their locality and had not been exposed to any institutions conserned with the development of rural enterprises. Nonetheless, the forest-based products provides the average exploiter with some means of livelihood.

Table 10: Products from Forest-based Enterprises: **(Sources: Field Data, 1996.)**

Product type	**Local name**	**Plant material made from**	**Price/Unit**	**No.of Units/year**	**Rev. in 1996**
Mat	Ute	Raffia fronds	-	-	-
Cap	Okpu	Palm			
Broom	Aziza	Palm frond	9	85	642
Bed	Akpakara	Bambo	1705	-	68050
Baskets	Nkata	Palm frond	20	98	2075
Fish net	Nzara	Raffia palm	-	-	-
Sponge	Sapo	-	-	-	500
Cane chair	-	cane plant	-	-	87725
Rope	-	Climbing plants&frond	-	-	4500
Raffia	Agwo	Raffia palm	100	-	12000
Honey	-	Honey bee	-	-	-
Bambo stick	Achara	Bambo plants	350	44	16200
Walking Stick	Nkpa	Forest plants	-	-	-

SUMMARY AND IMPLICATIONS

A proper valuation of the functions and services of tropical forests to indigenous populations and stakeholders is a sine qua non for efficient use and sustainable management of forest resources. This is because indigenous people who depend for their survival on wild species are central to any effort to conserve tropical biodiversity.

The study revealed strong manifestations of the economic functions of the forests which directly or indirectly contribute to the welfare of rural people. Of special importance is the reliance on tropical forests for a variety of fruits, vegetables and herbs. There was clear indications that these items played key roles in the food security of the people. Ranking high in importance is also the medicinal value of forests. Several medicinal plants available for various ailments, the respondents perceptions of their knowledge levels of medicinal plants, and the cash income realized from medicinal plants, all attest to the high medicinal value of the forests. Cash income realized from medicinal plants pales into insignificance when compared with amount realized from other forest products. This reflects the low level of commercialization of medicinal plants in the areas studied as well as the absence of institutional linkages and a lack of access to international markets.

The study has also employed the use of non market valuation techniques to establish the value of forests to indigenous populations although there was the tendency to undervalue forest resources due to low income values. The findings however indicate that the forests investigated provide essential raw materials and inputs that support assorted rural enterprises. Extracts such as oil palm-wine and raffia palm-wine are common products while many finished products from forest based enterprises were found to attract considerable commercial values in local and international markets. Again the absence of institutional linkages and lack of access to distant markets have exacerbated underdevelopment of these enterprises.

Policy Implications

In spite of the data limitations associated with rapid appraisal technique, it can be argued that this study component has resulted in a reasonable assessment of the economic value of non timber forest resources to indigenous people who live on the fringes of forests. More detailed studies are needed in other parts of tropical Africa to improve the database for sustainable management of forests. The results from this and similar studies can be incorporated in developement plans.

Such information can help government take decisions on:

1. Conservation of tropical genetic resources as a means of improving the rural economy.
2. Improving the welfare of indigenous populations who rely on forest resources for their well being.
3. Enabling local people to raise their incomes by monitoring the sustainable, economic utilization of forest resources.
4. Mobilizing local people to protect the resource base in their own interest. This effort could be institutionalized in local organizations that can act effectively to conserve the biodiverse habitat.
5. Provide policy analysts with data on non-market value of forest resources in addition to commercial value which has traditionally been used.

Results of this research can also be used by international drug development agencies to determine and influence appropriate compensation and distribution of royalties to institutions,

individuals, and rural communities for forgone access to forest resources or for intellectual contribution to the identification and processing of medicinal plants and their subsequent isolation and development as medicinal agents.

Generally, the results will highlight the importance of non-timber forest products, which have been neglected in the past in favor of timber. The study has identified the importance and value of some non timber forest resources to local people. Thus a concerted effort should be made to set up channels that would give local people stronger voice in decisions connected with forest resource management.

To sustain conservation practices among indigenous populations, it is necessary that pharmaceutical industry based on tropical forest related drug should be made to understand that a significant proportion of their revenues or benefits is returned to the indigenous communities. The same applies to non-medicinal forest products. Most communities which suffer the externalities arising from the exploitation of forests products should benefit from equitable distribution of the benefits from harvesting such products.

Forest management policies are shaped through a convergence of institutional interests among the stakeholders, communities, local government, national government, and international agencies. This convergence of interests should be recognized in any effort to ensure sustainable management of forest reserves.

Ethnobotany and Economic Valuation of plant species in Bafut, Sabga and Oku Tribes in Cameroon.

The economically useful species was investigated through studies of species selection, yield studies, regeneration surveys, harvest assessment and harvest adjustments to ensure sustainability of forest extraction for commercial purposes. Production and marketing of selected non-timber forest products is promoted. The income generated will be distributed in an equitable manner using a mechanism that respects the cultural norms of the community.

An ethnobotanical and economic valuation of Non-Timber Forest Products (NTFPs) was carried in the N.W. Province of Cameroon. This excludes commercially exploited timbers but included all other products including building materials, fiber sponge, leaves and mushrooms. They are particularly important to the rural poor who have no resources beyond the common forest.

Description of Study Areas:

The North West Province (N.W.P) is one of the ten provinces that make up the Republic of Cameroon. It has an area of about 17.409 km^2 lying between lat. 5°43' north of the equator and longitude 9°12' east of the Green Meridien. It is bounded on the west and north by Federal Republic of Nigeria, to the south by South West Province, to the south east by the Western Province and to the far east by the Adamawa Province. Although the N.W.P. is thought of as a grassland, there are valleys with humid tropical forests. The population from the 1987 national census was 1.2 million inhabitants with a growth rate of 2.92% giving a projected population of 1.6 million inhabitants in 1995 of which 33.3% is urban and 66.7% rural. There are no industries. The province is divided into seven administrative units called divisions. Each of these divisions is made up of seven tribes whose cultural backgrounds portray assorted and unique ways of utilizing the vegetation. Our choice of study areas took cognizance of this fact. Bafut and Sabga are in Mezam Division and Oku is in Bui Division.

Bafut::

Situated in the lowlands of Mezam Division was chosen for the following reasons:

a. the vegetation runs from Savannah to humid forest
b. Its population, although sharing boundaries with a cosmopolitan town – Bamenda, still clings a lot to its culture.
c. Their staple food is pounded cocoyams eaten with a special yellow soup made of palm oil and wild spices. All ingredients for this meal are collected from the forest. Bafut seems to be the only tribe in Mezam still possessing almost original forest reserves because of their addiction to these wild spices.

Sabga:

With the height of about 1700m is covered by woodland savannah and inhabited by the fulani pastoral farmers who excel in naming almost every forage or toxic plants found in their vicinity, and are able to describe its palatability to different species of livestock, its seasonability, its nutritiousness, toxicity if any, and medicinal or other uses. It is therefore a unique area for obtaining all the medicinal and ethnoveterinary plants especially those used for the preservation of milk.

Oku:

It is famous for its Kilum mountain range which is the second peak land in mainland West Africa (after Mt. Cameroon). The forest begins at 2000m near Lake Oku on the north side of the mountain and extends almost to 3000m (Stuart et al 1986). The Mount Kilum forest is rich in the following endangered medicinal species: *Prunus,Podocarpus, Schefflera* and Bamboo. The British Kilum mountain Forest project was established here. Apart from the biological significance, this forest is also of immense cultural and religious value. The economic value of the forest is of paramount importance to the natives who depend on it in various ways. It is also a huge watershed, which supply water for domestic and agricultural use. As an endangered ecosystem and an area of unique biodiversity, it offers a good base for scientific studies. No study in Cameroon would be complete without reference to Oku. It is often said that any disease, which cannot be treated by Oku traditional doctors, is bound to result in death. All these areas are densely populated, less developed and have fewer economic opportunities. Transportation is also a major problem during the rainy season.

Results:

TRIBE	1-Hectare Plot Survey	Household Survey	Market Survey	Focal Species
BAFUT	53	168	24	24
SABGA	57	204		25
OKU	64	175	24	11

The analysis of the survey provided an expansive picture of the way people value forests. The Bafut and Oku analysis revealed that plants contribute to almost all aspects of rural setting, from domestic consumption to even use of the forest as tissue papers, through processing envelope from plant to trade and commerce, medicine, building materials, household utensils as well as more intangible benefits such as cultural symbols, ritual artifacts and sacred sites.

Detailed trade information was collected in plant medicine, food wrapping leaves, bamboo mats, Indian bamboo, raffia and cane products. These products were traced from major markets back through supply channels to the rural gatherers. The data include estimates of the numbers of people involved, the quantities traded, purchase and selling prices, turnover rates, transportation costs, and an examination of marketing and supply problems. Finally studies of rural and urban consumption provided information on the demand for these NTFPs. It is evident also from the analysis that Fulani pastoralists value and use more plants than the natives.

Generally, the variation in focal species depended on the availability of indigenous plant species found in each tribe and hence the type of crafts seen around. The discovery of the mushroom industries that depend directly on forest plants gave a clue to forest degradation and extinction of certain plant species e.g. *Arundinaria alpina* and *Oxytenanthera abyssinica.*

The analysis also revealed women involved in forest management without any restriction except during their menstrual periods when they are not allowed to touch or uproot certain plants e.g. *Dracaena deisteliana; Raphia vinifera; Ceiba petandra;* and *Markhamia tomentosa.* They are also barred from entering certain forest shrines. A few of them were noted as seed savers and custodians of lost and rare crops as well as being conservationists or ethnobotanist. Majority earn income from food crop farming. The *"buyamsellam"* urban women earn their sales of oil palm products including food wrappers (leaves of Marantaceae and Musaceae families). Others in Bafut are involved in gathering wild spices from primary and secondary forest. Sixteen of these spices were identified. Almost all rural women have a good knowledge of medicinal plants which they use in treating their household thus saving money.

Throughout the study areas, many people interviewed did express concern about the problems of deforestation. Although the importance of the forest to both urban and rural people has been demonstrated but very little resources is channeled towards forest management planning. In examining the role NTFPs play in rural economies and their impact on forest degradation, there is need for the government to implement policies and educate users on sustainable utilization of forest resources. Also from the numerous local industries found, this study recommends the setting up of an oil palm, craft, and wild spices industries as a means of improving the status of the rural poor. There is also a need for the existence of an ethnoveterinay clinic to tap the huge ethnoveterinay knowledge displayed by the Fulani pastoralists.

At then end of the survey, recommendations will be made to the governments of Cameroon and Nigeria on the most effective manner for forest management. This will include reports on the value of forest products compared with other uses such as logging and clearing for agriculture. Results will be compiled and shared locally with communities, research institutions and universities for educational purposes and with conservation and development projects to assist in the development and implementation of applied programs.

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6-L. ATTACHMENT

Economic Value Assessment Studies: Tables 2 - 8.

ATTACHMENT

Table 2: Common Plant Species and their uses.

Plants	Family	Type	Uses	How Used	
Dacryodis edulis Igbo: Ube	Burscraceae	Fruit	Food	FC	Market Sold
Treculia africana Igbo: Ukwa	Moraceae	Fruit	Food	PC	Local
Pentaclethra macrophylla Igbo: Ukpakala/Ugba	Caesalpiniacea	Fruit	Food	PC	Local
Cola nitida Igbo: Oji	Sterculiaceae	Fruit	Stimulant	F	Local
Garcina kola English: Akilu/Akirilu	Guttiferae	Fruit	Medicine	F	Local
Mangifera indica(Mango)	Anacardiaceae	Fruit	Food	F	Local
Chrysophyllum albidium Igbo: Udara	Sapotaceae	Fruit	Food	F	Local
Irvingia gabonensis Igbo: Ugiri	Iru mgiaceae	Fruit	Food	FC	Local
Anacardium occidentalis Cashew	Anacardiaceae	Fruit	Food	F	Local
Psidium guajava (Guava)	Myrtaceae	Fruit	Food	F	Local
Musa sapientum (banana)	Musaceae	Fruit	Food	F	Local
Xylopia aethiopica (Uda)	Annonaceae	Fruit/Veg.	Medicine	C	Local
Elaeis guinensis Igbo: Nkwu	Palmae	Fruit/oil	Oil	PC	Local
Dennettia tripetala (Mmimi)	Annonaceae	Fruit	Medicine	F	Local

Table 2 (Contd.): Common Plant Species and their uses.

Plants	Family	Type	Uses	How Used	
Hevea brasiliensis (Rubber)	Euphorbiaceae	Fruit/latex	Latex	P	Distant
Diallum guineense (Icheku)	Caesalpiniaceae	Fruit	food/staking	F	Local
Gongronema latifolium Igbo: Utazi	Asclepiadaceae	Vegitable	Food/ medicine	FC	Local
Piper guineense Igbo: Uziza	Piperaceae	Vegetable	Food/ medicine	FC	Local
Gnetum africana Igbo: Okazi	Gnetaceae	Vegetable	Food	FC	Local
Naudea sp. Igbo: Uburu	Rubiaceae	Fruit	Food/ medicine	F	Local
Marantochlaoa leucantha Igbo: Ute	Marantaceae	-	Mat	P	Distant
Megaphrynium macrophyllum Igbo: etere	Marantaceae	Vegetable	Wrapping	F	Distant
Strophanthus hispidus Igbo: Osisi aguru	Apocynaceae	-	-	-	-
Aframomum melegueta Igbo: Ose oji	Zingiberaceae	Fruit	Stimulant medicine	F	-
Pterocarpus sayauxii Igbo: Oha	Papilionaceae	Vegetable	Food	F	-
Nauclea sp. Igbo: Ubulu		Herb	Medicine	P	-

Key:
F- Used Fresh
C- Used Cooked P- Processed

Sources: Field survey, 1997.

Table 3: Common Medicinal Plants and their Uses:

Local Name	Botanical Name	Family Name	Treatment
Abosi	Baphia nitida	Papilionaceae	skin infections
Akata	Rauwolfia vomitoria	Apocynaceae	fever, venereal disease
Akwukwoato	Ritchia sp.	Capparidaceae	Ear ache
Akukirikiri	Schwenkia americana	Solanaceae	antibiotics
Ndurukwundukwu	Hedranthera barteri	Apocynaceae	chest pains
Nsoechucho	Erythrina senegalensis	Papilionaceae	Dysentery, cough, fevers
Anuruagbo	Icacina sp.	Icacinaceae	Malaria
Oji gwuruwaike	Buchholzia coriacea	Capparidaceae	headache
Ahiha nwaebele	Icacina sp.	Icacinaceae	mental health
Uhi	Piptadeniastrum africana	Mimosaceae	women's stomach
Anuruagboo	Icacina sp.	Icacinaceae	Malaria
Duru ngwo	Manihot sp	Euphorbiaceae	eye pains
Akato	Allophylus africanus	Sapindaceae	malaria
Nwaegbuhuji	Sphenocentrum jollyanum	Minispermaceae	heart diseases
Ochocho	Jatropha curcas	Euphorbiaceae	chest pain
Abubannekeose	Napoleona vogelii	lecythdiaceae	mental cases
Aziza udo	Picarlima nitida	Apocynaceae	stomach condition
Isite	Eleusine indica	Poaceae	convulsion
Uringwa	Euginea sp	Myrataceae	eye trouble
Ayo-ohia	Haemanthus sp	Liliaceae	snake bite

Ndukwurundukwu	Hedranthera bartri	Apocynaceae	dysentry
Abuala	Combretum sp	Combretaceae	-

Table 3 (Contd.): Common Medicinal Plants and their Uses.

Local Name	**Botanical Name**	**Family Name**	**Treatment**
Anunwegbe	Alstonia boonei	Apocynaceae	stomach purge
Achara	Bambosa vulgaris	Poaceae	body pains
Ahiha nwaebele	Icacina sp	Icacinaceae	malaria
Uburu ilu	Nauclea sp	Rubiaceae	fever
Omause	Olax sp	Olacaceae	fever
Akiohia	Combretum sp	Combretaceae	purgative
Akata	Rauwolfia vomitoria	Apocynaceae	
Uburu ilu	Nauclea sp	Rubiaceae	impotency
Aganboogara	Spondias	Anacardiaceae	
Ajujunwagbono	Millettia sp	Papilionaceae	veneral disease
Uburu ochiri	Nauclea	Rubiaceae	malaria
Ohuru	Monodora myristica	Annonaceae	hook worm
Anurugbo	Icacina sp	Icacinaceae	malaria
Agurunta	-	-	-
Osisimbizi	-	-	-
Aka-ato	Crativa adansonii	Capparidaceae	stroke
Udele Kpa	Jatropha curcas	Euphorbiaceae	eye problems
Utos	Picralima nitida	Apocynaceae	painful mensturation

NwataKpasa ukwu	Mimosa pudica	Mimosaceae	
Ebere nkeafo	Euphorbia heterophylla	Euphorbiaceae	stomach
Akwukwo nkirisi	Desmodium sp	Papilionaceae	

Table 3 (Contd.): Common Medicinal Plants and their Uses.

Local Name	**Botanical Name**	**Family Name**	**Treatment**
Ihenmiri	Dalbergia sp	Papilionaceae	pains, fever
Uto anwu	Landolphia sp.	Apocynaceae	tuberculosis, female stelirity
Ngwu	Albizia sp.	Mimosaceae	skin infection, fevers
Ugere	Morinda incida	Rubiaceae	fever, anti-malaria
Arankita	Icacina sp	Icacinaceae	male impotency, aphrodisiac
Okwete	Costus afer	Zingiberaceae	cough, hypertension, aphrodisciac
Abosi	Baphia nitida	Papilionaceae	skin infection
Ezeazakma	Euphorbia hetrophylla	Euphorbiaceae	cough
Utazi	Gongronema latifolium	Asclepiadaceae	
Ugwo eba	Jatrophacurcas sp.	Euphorbiaceae	Malaria
Echi-echi	Croton zambesicus	Euphorbiaceae	
Nti-ato	Ritchia sp.	Capparidaceae	Stomach ache, ear ache, chest pain tooth ache, pele
Akum shorop	Azaderachta indica	Meliaceae	stomach pain, chest pain
Ologbo	Paullinia pinnate	Sapindaceae	abnormal mensuration
Atta	Imperata cylindrica	Poaceae	swollen body
Okwete	Costus afer	Zingiberaceae	-
Oke ogirishi	Newbouldia leavis	Bignoniaceae	wound dressing, stomach ache

Ezumezu	Paullinia pinnata	Sapindaceae	fever, jaundice
Onyega	Erythrina senegalensis	Papilionaceae	dysentary, cough, fevers
Osisi Kaguru	Strphanthus hispidus	Apocynaceae	Rheumatism
Ogbono	-	Irungiaceae	leaf decoction for fevers
Udara	Chrysophyllum albidium	Saptaceae	-

Table 4: Other medicinal plants commonly found in the Study areas.

Plant's Name	**Family Name**	**Part(s) Used**
Uvaria chamae	Annonaceae	roots
Enantia chlorantha	Annonaceae	roots
Cassyto aerial part	Vitacea	
Lophira lanceolata	Ochnaceae	roots
Spathodea campanulata	Bignoniaceae	stem/bark
Detarium microcarpum	Caesalpiniaceae	stem/bark
Chasmethra dependens	Menispermaceae	roots
Psidium guajava	Myrtaceae	leaves
Protea mediensis	Proteaceae	leaves
Morinda luciada	Rubiaceae	leaves
Afromonum danielli	Zingiberaceae	seed pericarp
Triumfetta tomentosa	Tiliaceae	roots
Mangifera indica	Anacardiaceae	leaves
Culcasia scandens	Araceae	whole plant
Gouania longipetala	Rhamnaceae	leaves
Sida acuta	Malvaceae	leaves

Boerhavea	Nyctaginaceae	leaves
Costus lucanusianuis	Zingiberaceae	leaves
Picralima nitida	Apocynaceae	seeds
Byrsocarpus	Connaraceae	leaves
Adenopus senegalensis	Cucurbitaceae	fruits

Table 4 (Contd.): Other medicinal plants commonly found in the Study areas.

Plant's Name	**Family Name**	**Part(s) Used**
Nelsonia canescens	Acanthaceae	leaves
Alstonia boonei	Apocynaceae	leaves
Eupatorium odoratum	Asteraceae	leaves
Moringa oleifera	Moringaceae	leaves
Pterocarpus	Papilionaceae	leaves
Borreria verticillata	Rubiaceae	whole part
Garcina kola	Guttiferae	seed
Newbouldia	Bignonisaceae	leaves
Pyrenacanth staudtii	Icacinaceae	leaves
Spathodea campanulata	Bignoniaceae	leaves
Acanthus mantanus	Acanthaceae	leaves
Erythrina sengalensis	Papilionaceae	roots
Enantia chlorantha	Annonaceae	stem bark
Lasianthra africana	Icacinaceae	roots

Guavea thomsponii	Bignoniaceae	stem bark
Cayratia ibuensis	Vitaceae	whole plant
Vernonia amygdalina	Asteraceae	leaves
Cryptolepis sanguinolenta	Asclepiadaceae	roots
Petersianthus macrocarpus	Lecythidaceae	stem bark
Prosopis africana	Fabaceae	stem bark
Draceansa mannii	Agavaceae	seeds

In addition, other medicinal plants commonly found in the study area are listed in table 4.

Table 5: Ranking of plant species by respondents.

Plant Specie				**Ranking (frequency)**							
Specie	Local/common name	Family	Uses	1	2	3	4	5	6	7	8
Strophanthus hispidus	Osisiaguru	Apocynaceae	M	3							
Nauclea sp.	Uburu	Rubiaceae	M		3						
Icacina sp	Anuruagbo	Icacinaceae	M	1		1					
Vernonia sp.	Olugbu	Asteraceae	FM	1	1						
Rauwolfia vomitoria	Akata	Apocynaceae	M	1		1					
Piptadeniastrum africanum	Uhi	Mimosaceae	M	1	1						
Landophia sp.	Utu	Apocynaceae	FM		1						
Albizia sp.	Ngwu	Mimosaceae	M	1	1						
Milicia excelsa	Iroko	Moraceae	M	1		1					
Carica papaya	Pawpaw	Caricaceae	FM		1						

Irvingia gabonensis	Ogbono	Irvingiaceae	FM	1	1						
Gongronema latifolium	Utazi	Asclepiadaceae	FM		1	1	1	1		1	1
Piper guineense	Uziza	Piperaceae	FM		3	3	3	1	1		1
Garcina kola	Akirilu	Guttiferae	SM		1			1			
Chrysophyllum albidium	Udara	Sapotaceae	FM		1	1	1				
Mangifera indica	Mango	Anacardiaceae	FM			1		1			
Azadiracta indica	Dogonyaro	Meliaceae	M								

Table 5 (Contd.): Ranking of plant species by respondents.

Plant Specie				**Ranking (frequency)**							
Chrysophllum albidium	Uda	Sapotaceae	FM				1				
Dacryodis edulis	Ube	Burseraceae			1	1					
Treculia africana	Ukwa	Moraceae		1	1			1			
Persea americana	Ubebekee	Lauraceae			1	1	1	1	1		
Pentaclethra macrophylla	Ukpakala	Leasalpiniaceae		1	1	1	1				
Cola nitida	Kola	Sterculiaceae		1		1					

Source: Field Data, 1997.

Table 6: Amount realised from sale of forest products by an average users in Imo and Eboyi states,

Nigeria.

Type of Forest Products	Family Name	1994	1995	1996
Dacryodis adulis (Ube)	Burseraceae	4700	5750	8050
Treculia africana (Ukwa)	Moraceae	12000	11700	22750
Gongronema latifoluim (Utazi)	Ascelpiadaceae	7300	16970	11660
Raffia	Palmae	45500	45550	70950
Gnetum africanam (Ukazi)	Cinetaceae	7587	13990	22230
Piper guineense (Uziza)	Piperaceae	8565	25765	20455
Pentaclethra macrophylla (Ukpaka)	Ceaselpmiaceae	36580	37725	45240
Cola nitida (Kola)	Sterculiaceae	15300	32300	41300
Garcinia kola (Bitter Kola)	Guttiterae	14600	14650	24000
Mangifera indica (Mango)	Anacardiaceae	5470	6970	10600
Chrysophyllum albidium (Udara)	Sapotaceae	4230	3260	5065
Urania lobata (Rope)	Malvaceae	300	-	3500
Nauclea sp. (Uburu)	Rubiaceae	65	-	-
Persea american (Av. Pear)	Lauraceae	6510	6200	8250
Xylopia aethiopica (Uda)	Annonaceae	1800	1900	2200
Irvingia gabonensis (Ugiri)	Irvingiaceae	5210	5610	9425
Vitex doniana (Achika)	Verbenaceae	1620	660	2595
Bambosa volgaris (India Bambo(Achara))	Poaceae	2.964m	17700	0.11315m
Anacardium occidentalis (Cashew)	Anacardiaceae	1500	1100	7000
Marantochola leucantha (Ute)	Poaceae	2000	2000	2000

Table 6 (Contd.): Amount realised from sale of forest products by an average users in Imo and Eboyi states, Nigeria.

Type of Forest Products	Family Name	1994	1995	1996
Hevea brasiliensis (Rubber)	Euphorbiaceae	.035m	0.25m	.022m
Irvingia gabonensis (Ogbono)	Irvingiaceae	800	13000	27000
Aframonum melegueta (Ose Oji)	Zingiberaceae	250	230	450
Chasmanthera sp. (Ogbo)	Menisperaceae	3800	4380	7500
Allophylus sp. (Okpu)	Sapindaceae	200	520	3500
Okobo		-	-	18500

Source: Field Data, 1997

Table 7: Income from medicinal plants

Plant species	Family Name	Plant part used	Period of collection	Freq. Of collection	Qty. Collected	P/Unit 1996	Mkt sold (L/D/F)	Total rev. 1996
Milicia-excelsa Oje	Moraceae	Leaf	All time	2	100kg	-	-	400
Albiziaso Ngwu	Mimosaceae	Leaf	"	3	300	-	-	1000
Ceiba sp. Ekpu	Bombacaceae	Roots	All season	1	100kg	-	-	300
Allophylus Okpu	Sapindaceae	Bark/Leaf	Weekly	4	235kg	-	-	500
Milicia excelsa Iroko	Moraceae	-	All season	6	480	-	-	1350
Irumigia Ugere	Irvingiaceae	Leaf	Anytime	5	435kg	-	-	8950
Bombax sp. Akpu	Bombacaceae	Root/Leaf	All season	3	300kg	-	-	900
Pterocarpus Ufi	Papilionaceae	Bark	Daily	2	100kg	-	-	2500
Adudu		Bark	Weekly	3	225kg	-	-	1100
Allophylus Okpuisi	Sapindaceae	Bark	All Season	2	15kg	-	-	450
Rau wolfia vomioria Akata	Apocynaceae	Leaf	Anytime	4	230kg	-	-	430
Spondias mombin Izikala	Anacardiaceae	Leaf	Anytime	4	400kg	-	-	850
Ricinoderdron heudelotic Okwe	Euphorbiaceae	Leaf	Anytime	3	230kg	-	-	700
Egburu		Bole	All time	1	50kg	-	-	150
Ufulu		Root	Anytime	1	25kg	5	-	150
Cocos nucifera Coconut	Palmae	Fruit	Once a year	1	30kg	15	-	6000
Elaeis guineensis Kernel	Palmae	-	Daily	1	20kg	55	-	900
Ritch Akwukwo-utisoto	Capparidaceae	Leaf	Daily	1	5kg	-	-	200

Table 7 (Contd.): Income from medicinal plants

Plant species	Family Name	Plant part used	Period of collection	Freq. Of collection	Qty. Collected	P/Unit 1996	Mkt sold (L/D/F)	Total rev. 1996
Obaze		Leaf	All season	1	100kg	-	-	150
Ogunoka		Whole	Daily	1	50kg	-	-	200
Mgbereke		Roots	Anytime	2	150kg	-	-	1100
Mauclea Ubulu	Rubiaceae	Roots	Anytime	1	50kg	-	-	2000
Vincentella sp. Ukpiri	Sapotaceae	Bark	Daily	1	50kg	50	-	25
Morinda lucida Ugere	Rubiaceae	Leaf	Anytime	5	435kg	-	-	8950
Diospyros sp. Akpuru	Ebenaceae	Root	Anyime	1	100kg	-	-	500
Strophanthus hispidus Osisikaguru	Apocynaceae	Root	Anytime	4	1 paint	9.5	-	-

Table 8: Willingness to Accept as Compensation (WTA) Estimates per unit of medicinal plant:

Plant species	Family Name	Plant parts used	Freq. Of collection	Qty. collected/week	No.of weeks in 1996	Amt. Willing to Receive per unit	Price of close substitutes
Imperata Eta	Poaceae	All parts	2	48kg	112	₦2.00	60
Ogwu Oka		Leave	5	178kg	157	-	8530
Pterocarpus Ahu	Papilionaceae	Leave	1	20kg	26kg	300	20
Olax vendis Osaja	Olacaceae	Stem	3	21kg	108	-	215
Oduloje		Leaf	4	90kg	241	-	100
Vernoia amygdalina Onugbu		Leave	2	350kg	107	-	3000
Solanium sp. Anara	Solanaceae	Leaf	3	14kg	78	-	2205
Cosos niacifera Coconut	Palmae	Root	1	26kg	26	-	50
Ukwa	Moraceae	Fruit	1	40fruits	-	-	100
Treculia africana Obelebe		Bark	1	25kg	81	-	20
Ukpuru		Waters	1	120kg	28	200	40
Adudu		Leaf	3	74kg	107	-	150
Erythrina senegalensis Echichi	Papilionaceae	Leaf	2	35kg	82	-	200
Aga		Root	1	100kg	-	200	-
Imperata Ata	Poaceae	Leaf	1	100kg	24	500	40
Musa sapientum	Musaceae	Root	1	-	28	500	-

Banana							

Table 8 (Contd): Willingness to Accept as Compensation (WTA) Estimates per unit of medicinal plant:

Plant species	Family Name	Plant parts used	Freq. Of collection	Qty. collected/week	No.of weeks in 1996	Amt. Willing to Receive per unit	Price of close substitutes
Milicia excela Iroko	Moraceae	Root	4	70kg	168	1200	120
Nauclea Uburu	Rubiaceae	Root	when needed	-	-	6000	2500
Ndurukwu		Root	-	-	-	6000	-
Ngoechucho		Root	-	-	-	6000	
Utiri		Root/Stem	-	-	-	5000	-
Nkokomelu		Root	-	-	-	8000	-
Akwukwo nkirisi		Leaf	-	-	-	4000	-
Nwatakpasi ukwu		Leaf	-	-	-	4000	-
Ahihia ebere		Leaf	-	-	-	6500	-
Oriagbo		Root	-	-	-	3000	-
Osisiachucha		Leaf	-	-	-	900	-
Abuko		All parts	-	-	-	200	-
Ahihia efe		Leaf	-	-	-	800	-
Ahihiagburuiigide	Ceasalpiniaceae	Leaf	-	-	-	2600	-
Pentaelethra microphylla Ugbakala		Bark	-	-	-	2400	-
Ogurumgbede		Root	-	-	-	150	
Gongronuma latifolium Utazi	Asclepiadaceae	Leaf	-	-	-	500	-
Xylopia aethiopica Uda	Annonaceae	Seed	-	-	-	5000	-

Uchasi		Root	-	-	-	150	
Ekelebe		Root	-	-	-	150	